Axel Koukkula 38822
Master's thesis in accounting

R&D activities in recessions: Implications on Nordic firm performance

Supervisor: Prof. Matti Skoog

Faculty of Social Sciences, Business and Economics
Åbo Akademi University

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Abstract for master's thesis

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Writer: Axel Koukkula
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Abstract: This thesis investigates whether the research and development (R&D) activities of the firm impact future firm performance, and whether differences in these R&D activities during recessions could explain later performance differences among firms. This study uses a Nordic firm sample – analysing accounting data consisting of Finnish and Norwegian listed firms from 2007-2018. Using heteroscedastic-robust multiple regression analyses and non-parametric tests, how pre-recessionary and recessionary R&D activities impact on sales growth, profitability, and market valuation was examined with panel data of the 90 listed firms. The findings contradict the generally positively viewed relationship between R&D activities and measures of firm profitability and sales growth. Higher R&D intensity pre-recession led to worse recessionary firm profitability, whereas it still had a positive impact on the following year's market valuation. Recessionary R&D intensity demonstrated significant negative effects on firm performance upward six years into the post-recessionary period, albeit without consistent results indicating a specific trend. Any disparity in profitability or sales growth post-recession among those firms that increased or decreased R&D intensity during the recession, could not be detected. Rather than offering definitive answers regarding the relationship between firm performance and innovation, this thesis contributes to the scarce collection of research into the strategical actions of firms during recessions, studying whether these actions could be a source of sustained competitive advantage for firms. In addition to this, it offers a multitude of opportunities for further research, entailing the need for additional multidisciplinary studies.
Keywords: R&D, RBV, recession, firm performance, profitability

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1 INTRODUCTION

This chapter will begin by providing background information about the subject, followed by a problem discussion that will describe the problem area further. Additionally, the purpose of this study will be presented, along with the limitations of the research. Lastly, the structure of this thesis will be presented.

1.1 Background

> *A company can outperform rivals only if it can establish a difference that it can preserve.*
>
> (Porter M. E., 1996, p. 62)

What causes performance differences between firms and the variance in the timespans of such performance differences? Understanding how to acquire a competitive advantage and sustaining such an advantage has been the main mission of research in the field of strategy, with varying approaches for analysis over time (Levinthal, 1995). According to Michael E. Porter (1985), a sustained competitive advantage is to attain above-average performance in the long run. Finding these "market-beating" strategies, which would consistently result in excess returns in the long term, has also been one key interest in the field of financial research, although, achieving this has proved to be complicated, if not impossible. The efficient market hypothesis (EMH) has been the principal hypothesis within finance since Eugene F. Fama (1970) reviewed it in his famous research paper (Shleifer, 2000), despite the criticism the hypothesis has received both empirically and theoretically. On an efficient market, prices would fully reflect all available information and assets would be priced "correctly", thus reaching above-average performance would be impossible in the long term.

When discussing firm investments, firms may be considered as investors in strategic factor markets, where resources can be obtained to implement product market strategies (Barney J. B., 1986). These resources could imply physical investments, or inputs for non-tradeable intangible assets as well. To profit from these physical assets would require pricing inefficiencies in the factor market, which would enable acquiring the assets below their real value; that is, through the exploitation of information asymmetries in the factor

markets. The process of profiting from intangible assets is arguably more complex, as these assets assume an elusive and more abstract form, which results in arduousness when measuring asset-specific output. This unique, slippery nature of the intangible assets is also one primary reason why they are considered as one vital source of potentially acquiring a sustained competitive advantage (Barney J. , 1991). Intangible assets, due to their firm-specific nature, require them to be internally accumulated over time (Dierickx & Cool, 1989), whereas physical assets can be bought with relative ease from these factor markets. Thus, for firms to gain a sustained competitive edge against other firms, they either need to internally accumulate strategically important non-tangible resources or acquire tangible resources from factor markets below their real value.

As theories regarding finance, strategic management, or economics are developed, more often than so are they based on simplified assumptions of the reality, for the sake of creating a flexible model to explain the relationships between different variables. One such example of a simplified assumption is the neutral state of the economy in a market or country, also known as the market equilibrium. In reality, the economy is more cyclical to its nature; where periods of booming growth are followed by, sometimes even a severe decline in growth (Benkemoune, 2009). One such example of a severe downturn in the economy was the Great Recession, triggered by the financial crisis of 2008 and felt globally throughout all developed economies, with varying severity in different countries and industries (Suni & Vihriälä, 2016).

1.2 Problem discussion

Although it is generally agreed among the circles of scholars and practitioners alike that recessions dramatically affect the competitive landscape of firms, relatively little research on the strategical choices of firms has been done in the setting of a recession (Latham & Braun, 2011, p. 111). Within the strategy literature finance is generally dismissed as uninteresting, as the market efficiency is too high on the financial markets to explain differences in firm performance (Peteraf, 1993). Also, projects will access financing as long as the net present value (NPV) is positive. These assumptions are admittedly oversimplified for several reasons.

Firstly, as Knudsen and Lien (2014) present, the efficiency of the financial markets may vary over time, as recessions may cause demand reductions and issues in credit

availability. Secondly, the characteristics of an asset may affect its difficulty to acquire financing, as tangible assets acquire cheaper external financing than intangible assets (Czarnitzki & Hottenrott, 2011). Lastly, Hall (2010) suggests that firm characteristics may also affect the difficulty in accessing financing for investments, as established firms may have easier access to external and/or internal financing than new firms. Therefore, it is of relevance to combine strategical and financial theories for a comprehensive overview of how and why investments during a recession might affect future firm performance.

The paradox of strategy and finance derives from the difficulties in financing the assets that are considered as the most important from a strategic point of view, that is, intangibles. According to the resource-based view (RBV) (Barney J. , 1991), with an increasingly tangible nature of an asset, it has an inversed effect on the potential of the asset to become a source of competitive advantage. While there exists research within the fields of finance and economics about investments and how they are financed (Fazzari, Hubbard, & Petersen, 1988), there are some relevant gaps in the literature. The first gap is the traditional focus on physical investments, which derives from the results being simpler to calculate with clear inputs and outputs, whereas intangible investments are more complex to measure in the form of output. The second identified gap in the literature is the tendency not to link these investments and the source of financing to firm performance. For these reasons, by combining resource-based view and investment theory from finance, it would be possible to investigate further competitive advantages within industries on an asset- and a firm-level.

1.3 Purpose of the study

The purpose of this thesis is twofold. Firstly, it is to analyse whether firms' R&D spending affect future financial performance, in regard to the business cycle phase. Secondly, it is to study whether differences in firms' R&D activities during recessions can explain firm performance differences. As prior research has been concentrating on a recession's impact on firms' investments, this study will be a humble attempt to further fill the gap in the literature by investigating the relation between firms' later performance with firms' R&D activity during recessions in the Nordic countries.

1.4 Limitations of the study

This study will be limited to the Nordic equity market, and more specifically to the companies listed on the main market of Nasdaq OMX Nordic, including companies from the Helsinki and the Oslo Stock Exchange. As the study requires access to accounting figures for the research period, it limits the pool of firms to only include publicly traded companies. The time period of research will begin before the 2008 financial crisis and end in 2018, thus, the examined time period will be 2007-2018.

To further limit the study from extending too wide, this thesis will not examine the financing viewpoint of research and development (R&D) activities nor how these projects are valued. The theory chapter will present how accounting standards interpret R&D spending, albeit it will not partake in-depth in the problematic discussion regarding expensing or capitalising the R&D expenditures.

Without access to additional data regarding e.g. patents, type of research, and innovation figures, assumptions on intensity will be made based on accounting figures from the annual reports. Also, differences in the accounting standards GAAP and IFRS regarding R&D spending may affect the results, when comparing the Nordic firms to earlier research based on U.S. firms.

1.5 Research question

This study aims to answer the following research questions:

Does R&D spending affect future firm growth and profitability during periods of recession and economic expansion?

and

Can firm performance differences be explained by differences in R&D spending during recessions?

The two research questions are very much linked, as for the second question to even be plausible, the first one needs to be true to at least some extent. Therefore, to provide a broader analysis of the R&D activities' effect on firm performance, this thesis will examine both viewpoints.

1.6 Structure of the thesis

Chapter one contributed with a concise introduction to the topic of research and problem discussion. Further, a walkthrough of the research purpose as well as limitations of the study was provided. Lastly, the research questions were presented.

Theories relevant to the research will be presented in chapter two. The focus in the chapter will be on determining firm performance, discussing intangible assets from the viewpoint of R&D, and lastly, business cycles, and recessions.

Chapter three provides insight into prior research within the fields of strategical management, accounting, economics, and finance. The aspect of the research will be focusing on resources and firm performance, as well as the recessionary effects on R&D and firm performance. Finally, the hypotheses for the thesis will be presented.

The fourth chapter will present the research design of this study. The quantitative research process and choice of method will be discussed. This will be followed by introducing the data gathered, describing the used variables and the regression models. Lastly, concerns regarding the data and the study validity will be discussed.

Chapter five presents descriptive statistics of the dataset and test results of data normality. Then, the results from the regression analyses and the non-parametric tests will be shown. The chapter concludes with a summarisation of the findings.

The sixth chapter discusses the key findings, the theoretical implications of these findings, and the suggestions on further research within the field of study. Lastly, the limitations of the study and the quantitative model are discussed.

Chapter seven will offer a conclusion of this thesis and its implications for current research and theories.

Lastly, chapter eight will include a summary of this thesis in Swedish.

2 THEORETICAL BACKGROUND

This chapter is to provide insight into the basic theories regarding the subjects to be analysed in this thesis. Firstly, determinants of firm performance will be explored, with the point of view on both the external as well as internal environment of the firm. This will be followed by a discussion on firm resources from the aspect of intangible assets, more specifically on R&D – its implications on current accounting standards, firms, and industries, as well as suitable measures for firm performance in relation to R&D. Lastly, the external environment of a firm will be presented through a broader, macro-economic perspective discussing business cycles and recessions.

2.1 Determining firm performance

Comprehending the origin of firm performance has been a key interest for researchers both within economics, as well as the field of strategy. Why do some firms acquire superior performance compared to its peers, while some show constant underperformance in relation to the competitors? In the 1960s and 1970s, a considerable amount of empirical research on firm performance emerged; generating essential insights in firm profitability variation (McGahan & Porter, 2002). The goal of these studies was to investigate the link between fundamental barriers of market entry, tacit collusion, and firm performance; however, these studies tended to assume the structure of an industry is defined independently of firm performance. This led to studies in the 1980s challenging these early assumptions, developing a new form of research, which was pioneered by Richard Schmalensee.

Schmalensee (1985) decomposed variation in firm profitability into components of firm-specific, corporate-parent and industry effects. The return on assets (ROA) was the unit used as measure for firm profitability in his study of 465 U.S. firms in 1975. The paper found industry effects to be the main variable of explanation in firm profitability variation; albeit, only a single year was studied and therefore it does not consider year effects or persistency of performance. Later, these findings were disproved by Richard P. Rumelt, who found firm-specific effects to be the pivotal variable explaining the differences in firm profitability (Rumelt, 1991). His analysis expanded the time period from 1975 to 1974-1977, including thereby fluctuating and stable industry effects that were not included in Schmalensee's (1985) original work.

As both Rumelt (1991) and Schmalensee (1985) find industry and firm-specific effects to be key variables of explanation for firm performance variation, the following subchapters will discuss these effects by considering them as the environment for firms to operate in; namely, the external respective the internal environment of a firm.

2.1.1 Firm's external environment

One of the presumably most well-known frameworks within the field of strategy research in analysing a firm's external environment is the Five Forces analysis pioneered by Michael E. Porter (1980). The external environment of a firm, also known as its industry, consists of suppliers, customers, and lastly, competitors (Grant, 2016). Rating the attractiveness of a specific industry depends on the bargaining power of the suppliers, the value of a firm's products to its customers, as well as the intensity of competition. In Porter's (1980) framework, these are applied into two different "streams" of competition: namely, *horizontal* and *vertical*. The horizontal competition includes the threat of substitutes, the competition of established rivals, as well as the threat of new entrants to the market. Vertical competition on the other hand is based on the supply chain of a firm; the bargaining power of suppliers respectively buyers. The aggregate competitive pressure of these two "streams" determines the profitability and attractiveness of an industry; therefore, the weaker these forces are, the higher chance of acquiring superior performance.

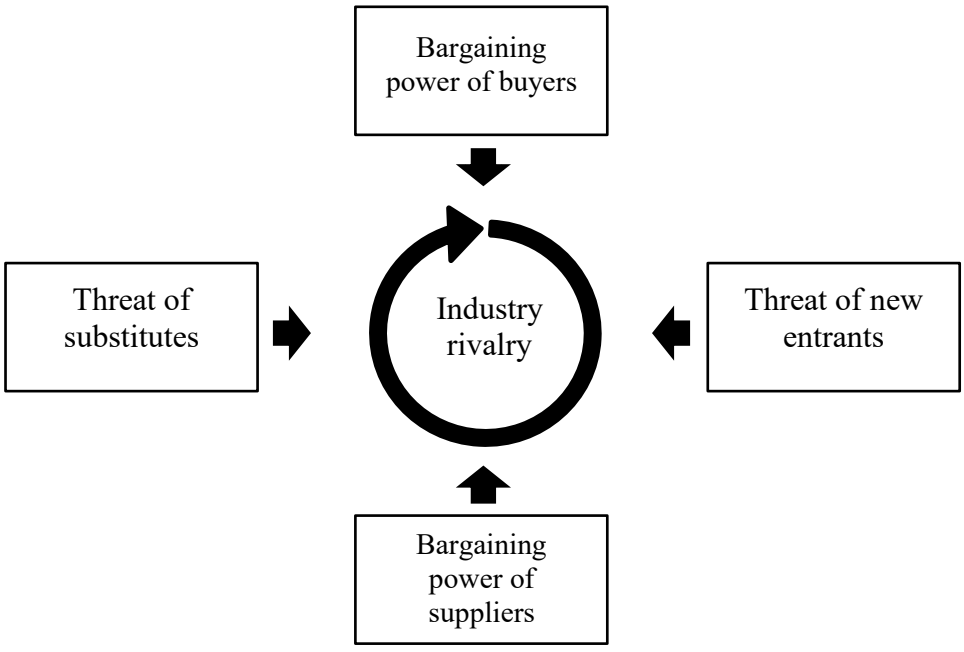

Figure 2.1 Porter's five forces framework

Porter (1985) suggests that firms may identify their best positioning in an industry through the five forces model; consequently, being able to defend themselves against threatful forces and construct a suitable strategy to counteract. Considering this framework, it would be possible even for firms with homogenous resources to acquire a sustained competitive advantage *if* they can manage their competitive environment properly.

Nevertheless, while the external environment of a firm admittedly does play a pivotal role when determining variation in firm performance, more recent research has shown its effect to be smaller than earlier assumed. In a study conducted by McGahan and Porter (2002), their findings suggest that environmental factors only account for 10.3 percent of the variation in firm profitability, while corporate-parent effects were liable for 11.6 percent of the variation. The largest identified source of variation in the profitability of firms was firm-specific effects, responsible for 36 percent of the total variation. The outstanding estimated 40 percent was considered to be unexplainable variation, resulting from short-term profitability differences, luck, coincidences, or issues in the research methodology.

Lastly, as the underlying assumption of an industry's attractiveness in Porter's framework originates from the ownership of assets, it further ties the external environment of a firm into the following subchapter discussing the firm's internal environment (Grant, 2016).

2.1.2 Firm's internal environment

Throughout the late 1970s and into the 1980s, the main foci in the field of strategy were on the firm's external, competitive environment, which was deemed as the main determinant for a firm's potential for profitability (Grant, 2016). In the 1990s, this focus in strategy shifted towards the internal environment of the firm, partly as a reaction to the dominant perception purely on the external environment prior. The lack of considering resource deployment in order to achieve or defend such a favoured position on the product markets, was indeed one reason for this shift of focus. Following, this resource deployment entails costs for implementing these product market strategies, which must be considered. This neglect gave birth to Barney's (1986) paper, presenting the idea of a strategic factor market, where strategically fundamental resources could be acquired.

Barney argued that the profits from a strategy are dependent on the costs of implementing it, while the costs depend on the related strategic factor markets. If these strategic factor markets would be considered fully informationally efficient, all expected profits would subsequently be competed away. According to Barney (1986), for a firm to be able to acquire factors below their real value, it would require them to either possess superior information, to be lucky or both; therefore, being comparable to the semi-efficient form of EMH (Fama, 1970). This could derive from possible differences in the valuation of the expected future value of resources, as the value of a specific resource is not automatically identical to all buyers and sellers. Ensuing the heterogeneity of resources, it is improbable that firms possess identical complementary resources; which in turn, may affect positively or negatively a firm's valuation of a specific resource (Denrell, Fang, & Winter, 2003). Further, most of the intangible assets cannot be acquired directly through factor markets but rather accumulated internally within the firm over time (Dierickx & Cool, 1989). Accordingly, these intangible assets also offer firms an increased chance of building a sustained, inimitable factor; that is, determined by the imitability degree of the accumulation process.

Following this, Barney (1991) proposed a model of firm performance, focusing on the capabilities and resources commanded by firms. This resource-based view considers a firm's true value to reside within its resources, either tangible and/or intangible, along with the capability of deploying these resources effectively. Ultimately, this will lead to a sustainable competitive advantage for a firm (Barney J. , 1991; Peteraf, 1993; Wernerfelt, 1984). Firm resources may be interpreted as "all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enables the firm to conceive of and implement strategies that improve its efficiency and effectiveness" (Barney J. , 1991). These firm resources may further be divided into tangible and intangible assets, where tangible assets are represented by physical and financial capital, while intangible assets consist of resources such as organizational and human capital. These two forms of assets will be discussed more in-depth in chapter 2.2 and its subsequent subchapters, with the focus primarily on intangible assets.

The resource-based view rests on two main assumptions when considering the resources and capabilities of a firm (Barney J. , 1991; Peteraf, 1993). Firstly, firms may be

heterogeneous with respect to the resources they control, indicating that firms, regardless of their operating industry, may possess divergent combinations of resources and capabilities. Secondly, resources are assumed to not being perfectly mobile, enabling persistence in the heterogeneity over time. This may be interpreted as arduousness in acquiring the resources in factor markets, which eventually may lead to long-lasting heterogeneity (Crook, Ketchen, Combs, & Todd, 2008).

Further, there are four criteria a resource must meet to be deemed a potential source for sustained competitive advantage, according to Barney (1991; 1997). Firstly, it must be *valuable*, in a manner of either exploiting opportunities and/or neutralising threats in the environment of a firm. Secondly, it must be *rare* among competitors, being merely in the hands of a relative few, if any. Thirdly, it must be *imperfectly imitable* by competitors with a significant cost disadvantage to a firm trying to obtain, develop, or duplicate the resource. Fourthly, and lastly, the firm is to be *organised* in a way to be able to exploit the resource efficiently. These four aspects of resources are known as the VRIO framework, a commonly used strategic tool for resource analysis within literature and management practice (Grant, 2016).

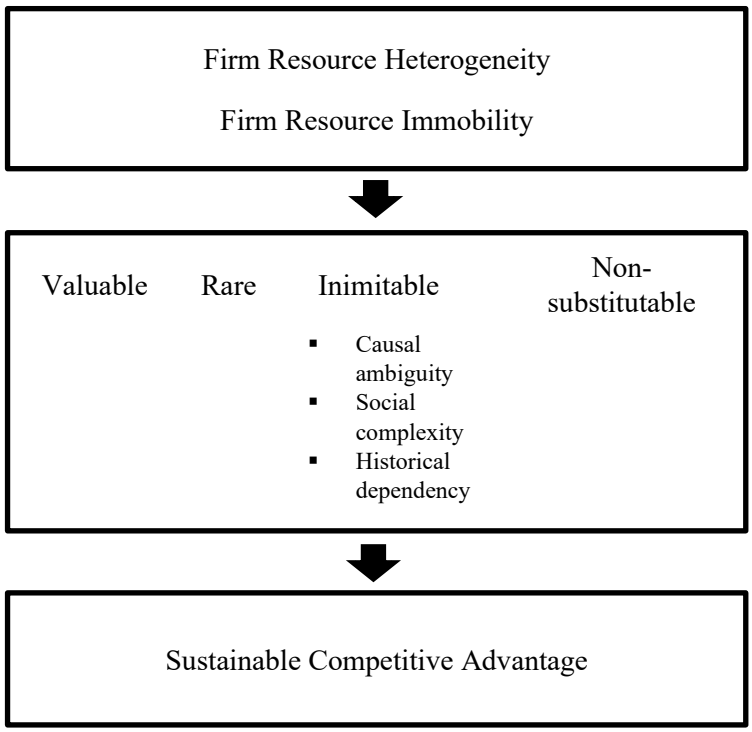

Figure 2.2 Linking resource characteristics & sustainable competitive advantage (adaption of Barney 1991)

By default, valuable and rare resources do not offer firms a source of sustained competitive advantage, unless these resources cannot be obtained by competing firms (Barney J. , 1991). The substitutability of a resource will lead to diminishing returns to the holders of the given resource (Wernerfelt, 1984), as the existence of substitute resources will cause the resource to lose its ability to create a sustainable competitive advantage to the original firm. This further supports the inimitable and non-transferable feature that the resource is to possess. The causal ambiguity of a resource implicates the degree of difficulty in assessing the causal relationship between the resource and firm performance. Reed and DeFillippi (1990) highlight specificity and complexity as factors that tend to increase the causal ambiguity of a resource, in addition to tacitness. Resources related to firm-specific tasks or skills have a lower value in alternative use, while tacitness implies the inherent and non-identifiable knowledge of actions taken. Social complexity is closely linked to intangible assets, such as firm reputation and trust, both costly and time-consuming for imitation attempts (Dierickx & Cool, 1989). Finally, if a firm achieves to acquire valuable and rare resources due to unique, historical circumstances it may implement unique value-creating strategies with these resources in a way that is inimitable by competitors (Barney J. , 1991).

The key takeaway from the resource-based view is to understand its implication for firms' opportunity to gain an advantage over their peers. For a firm to possess valuable and rare resources, it enables the potential for a competitive advantage. Further, if the firm is able to exploit these valuable and rare resources in a suitable manner, they can realise a competitive advantage. Lastly, if these resources and capabilities cannot be substituted or imitated, the firm will sustain this competitive advantage.

2.2 Assets and investments

As Barney (1991) emphasises, firm resources play a remarkable role in determining firm performance, more so than the external environment of a firm. In accounting terms, these resources take the name of tangible and intangible assets that are found on the firms' balance sheet.

In the 2018 revised Conceptual Framework, The International Accounting Standards Board (IASB), defines an asset as: "A present economic resource controlled by the entity as a result of past events. An economic resource is a right that has the potential to produce

economic benefits" (IASB, 2018). This updated definition has discarded the former requirement of the potential economic benefits to be *expected* to flow to the entity, as the new definition requires no certainty or likelihood of economic benefit. This new definition is certainly long-awaited, as the old definition has indeed been problematic, most notably for intangible assets (Lev B. , 2019). This will be discussed more comprehensively in an upcoming subchapter presenting accounting for intangible assets, namely R&D.

Combining multiple fields of research, namely accounting, strategic management, and economics, has proven itself difficult from time to time regarding the terminology used. The accurate definition of *investing* and *investments* has found itself to be very much like the issue related to the definition of *assets*, varying in the literature from the different fields of study.

When discussing investments from the viewpoint of economics or accounting, both share the view of it being something that is not consumed immediately, but rather over time. Therefore, investments should be and indeed are, included in the balance sheet of a firm, where they are then amortised over time. In contrast, in literature and research papers within the field of strategic management, the definition of firm investments is more simplified and arguably sloppier. Here investments in R&D are clustered into one, seemingly asset-like entity, without differentiating the amounts that will be expensed immediately and those that are capitalised; mainly research respectively development.

To gain further insight into research and development characteristics, the following subsection will present reasons for firms' R&D activities and industry differences, along with financing characteristics for the intangible asset. Following that, I will discuss in detail the current viewpoint on accounting for R&D, as well as the criticism the accounting standards have met regarding this definition. The last subsection will provide insight into how firm performance will be measured in this thesis, in relation to R&D spending.

2.2.1 R&D activities in firms and industries

Research and development (R&D) are considered to have an essential role in the stimulation of innovation and economic growth, along with being a key source for

competitive advantages in the modern economies (Bottazzi & Peri, 2003). Reflecting back on the resource-based view and VRIO-framework provided by Barney (1997), many attributes that are thought to be linked to sustained competitive advantages, are heavily related with intangible assets, and subsequently, in R&D. It is highly firm-specific, complex regarding the identification of the relationship between input-output, abstract as in the form of human capital and knowledge, along with inimitability in the form of e.g. patents. R&D is therefore proven to be a vital part of a firm's intangible assets, signalling the firm's endeavour to improve and strengthen the firm's competitiveness (Chan A. L.-C., 2012).

Successful, continuous development of innovative products or processes in this fast-changing, increasingly technology-driven world has led companies like Apple, Microsoft, Alphabet, and Amazon to reach over $1 trillion market capitalizations (Wakabayashi, 2020). While successful development and improvement of new products, processes, and services have led to sales growth, increased market value, and reduced production costs, this can only be observed in hindsight (Xu & Zhang, 2004). Due to the elusive, abstract nature of research and development, there is no guarantee that the investment is successful. It may in fact, turn out to be a failure even though the R&D activities would have been fruitful, generating commercialized products. One practical example of this was Nokia that generated cutting-edge products within its field of specialisation, although due to lost customer focus, it managed to lose its role as the market leader (Bouwman, et al., 2014). Therefore, it is of importance to identify that research and development solely do not lead to firm success, but rather is a part of the process of identifying opportunities on the market depending on customer needs.

Industries also differ quite considerably regarding their research and development activities – some might annually spend a fifth of their revenues on R&D, while other industries might spend under one percent of their revenues if anything at all. The environment of competition varies between the different industries, which also results in differences in the useful life of R&D (Lev, Nissim, & Thomas, 2008). Dependent on the industry a firm belongs to, it might be assumed to invest more or less in R&D activities (Xu & Zhang, 2004). Typically, R&D-intensive industries are sectors such as pharmaceuticals and technology, as firms are dependent on providing new products – either in the form of new medicine or technological products and services. Industries that

do not interpret R&D activities as their main competitive factor, such as oil & gas, utilities, and industrial metal industries, tend in turn demonstrate lower R&D intensities (Tubbs, 2007).

R&D activities, like any other form of firm investment, also require financial resources. A major portion of the R&D costs derives from wage and salary costs of the employees, that are usually highly-skilled and that have gradually amassed the experience and accumulated research capabilities over time (Czarnitzki & Hottenrott, 2011). Due to R&D activities being highly connected to the human capital of the firm, adjustments in the level of spending would be highly costly, as it would require layoffs for reducing costs and costly hiring and training of staff for increasing the R&D level of input. Therefore, there tends to be low volatility in the R&D costs of a firm, as investments are smoothed out over time (Coad & Rao-Nicholson, 2010).

Financing R&D is mainly done with internal capital, if possible, for several reasons. As R&D has a considerable high level of uncertainty regarding the output, it is deemed more costly to be financed with external capital than tangible assets (Czarnitzki & Hottenrott, 2011). This is also due to R&D being highly firm-specific with low salvage value – affecting as such its value as collateral for creditors and banks. Furthermore, there exists an information asymmetry between the firm and potential investors, as the firm is reluctant to share R&D information that could be imitated by competing firms (Hall, 2010). Lastly, as R&D is preferably internally financed, in the event of facing financing constraints, firms may need to make involuntary cuts in R&D spending – eventually leading into lasting disadvantages compared to competing firms (Knudsen & Lien, 2014).

2.2.2 Accounting for intangible assets: R&D

The accounting treatment for intangible assets is defined by IASB (2017) in International Accounting Standards (IAS) 38, revised in March 2004. It is stated that research expenditure must be expensed as incurred and that no intangible assets stemming from research shall be recognised. Development expenses, on the other hand, may be capitalised (and amortised), although, only if a firm can demonstrate that all the following six requirements are fulfilled:

1. the technical feasibility of completing the intangible asset so that it will be available for use or sale, and
2. firm intends to complete the intangible asset and use or sell it, and
3. firm has the ability to use or sell the intangible asset, and
4. firm is capable of verifying that the intangible asset will generate future economic benefits, and
5. firm has adequate technical, economical and other resources to complete the development and either use or sell the intangible asset, and
6. firm is able to reliably determine costs stemming from the development phase of the intangible asset. [IAS 38.57]

This is relatively analogous to the U.S. GAAP accounting treatment of research and development, although with a few differences. The Financial Accounting Standards Board (FASB) (1974) states in Statement of Financial Accounting Standards (SFAS) No. 2 that all R&D expenses are to be immediately expensed, with the exception being acquired in-process R&D that is to be capitalised[1]. According to Lev (2019), FASB's reasoning for the R&D expensing in 1974 was based on their viewpoint of assumingly missing direct relationship between R&D costs and specific expected revenue, something that has been met with increasing criticism as outdated information.

The rate of investments in intangible assets has continuously grown in importance over the span of the last two decades in the OECD economies, with even an increasing frequency of surpassing tangible investments (Corrado, Haskel, Iommi, & Jona-Lasinio, 2012). This is largely due to intangibles being increasingly important for firms' productivity growth through new technologies and knowledge (Demmou, Stefanescu, & Arquié, 2019). Due to, inter alia, largely outdated accounting standards (Lev B. , 2019), a majority of the intangibles are, albeit their considerable size, not visible to stakeholders examining a firm's financial reports.

Insufficient inclusion of these intangible assets in the financial reports had already been noticed in Sweden during the late 1980s, as the book *The Invisible Balance Sheet* was published by the Konrad group (1988). In the book, the authors point out that at an

[1] Additionally "An exception is the development costs of software for sale which should be capitalized (FASB, 1985), yet most… ignore the standard and immediately expense this investment" (Lev B. , 2019, p. 713).

increasing rate, firms are not able to present vital intangible assets effectively in financial reporting documents, as the accounting standards and performance measures are predominantly based on more traditional industries and key ratios based on the financial capital. For knowledge-based firms as in industries like consulting, law or auditing, their most important resource is the highly educated personnel, in other words, human capital. The authors call for the need of new accounting standards for these knowledge-based firms, as the current financial statements and key ratios do not provide investors enough information to make sound investment decisions, due to the currently invisible value of intangible assets for these firms (Konrad group, 1988).

Undervaluation is a risk that many small and/or young R&D-intensive companies face, as Lev (2004) points out in his paper. This undervaluation may prevent the companies from raising funds through the capital markets or cause the unneeded higher costs for acquiring this capital. Established companies, such as the earlier mentioned ensemble of tech giants with exceeding $1 trillion market capitalizations, have a proven ability to turn their intangible assets into results of tangible nature, and thus, do not face the same dilemma of undervaluation by default (Lev B. , 2004). This undervaluation could be considered as a result of the aforementioned lack of information available from the financial statements.

Lev and Sougiannis (1996) attempted to enact the objectivity, reliability, and value-relevance of the capitalisation of R&D in their paper, by examining the link between R&D expenses and the following earnings in a number of R&D-intensive U.S. firms. The authors find a strong relationship between the reported earnings, book values, stock prices, and returns; further implying that investors indeed obtain value-relevant information from the process of R&D capitalisation. Additionally, Sougiannis (2015) points out that the R&D capital is not fully reflected in the stock prices, indicating a feasible systematic mispricing of R&D-intensive firms (Eberhart, Maxwell, & Siddique, 2004; Lev, Nissim, & Thomas, 2008) or alternatively, an additional factor for risk related to R&D that is compensated by excess returns (Chan, Lakonishok, & Sougiannis, 2002; Leung, Mazouz, & Evans, 2017). The author also lists insufficient acknowledgment of the intangibles and outdated accounting practices (Baruch, Sarath, & Sougiannis, 2005), along with analysts' and investors' inability to decipher the implications on eventual

patent information as possible reasons for the mispricing of these firms (Sougiannis, 2015).

These differences in accounting standards have been noted in the process of writing this thesis. As for the two Nordic countries included in this analysis, by only including publicly listed companies in the sample that have adopted the International Financial Reporting Standards (IFRS) as their main form of reporting accounting figures, the financial statements will be comparable throughout the firm sample. Also, in order to acquire a more comprehensive picture of the sample firms' R&D activities, I will include both the expensed amount from the income statement, as well as the capitalised amount from the balance sheet, on an annual basis.

2.2.3 R&D and firm performance

Establishing suitable indicators to measure firm performance is a key variable for a study, as Selvam et al. (2016) identifies nine different determinants that are based on the needs of different stakeholders. Some of these are more internally oriented, such as employee satisfaction and social performance, while most assume a role towards external reporting and financial performance, by the likes of profitability, market value, and growth. These measurements of financial performance will be the base for this thesis as well, as most of the related research adapt equivalent approaches.

Basing the models on data from financial reports, among others, also imply intrinsic biases within variations in accounting standards and practices. Well-performing firms tend to deflate their accounting figures to lessen the tax burden, while firms performing poorly tend to attempt inflating their accounting figures to attract investors. Consequently, this will affect the bottom-line and subsequently, measures of profitability.

As this thesis aims to link firm performance to the firm's R&D activities, one suitable ratio for measuring profitability is the return on assets. The ratio return on assets (ROA) uses net income in relation to total assets for measuring profitability, measuring the firm's ability to utilise assets to earn money for investors. ROA will further be affected by different factors such as tax rates, depreciation, and R&D expenditure. These factors vary not only between countries and firms but also as a result of differences in the accounting standards of GAAP and IFRS. Therefore, when using ROA as one measurement for firm

performance, these differences need to be considered when making comparisons to earlier studies.

Another measure of firm profitability is the EBITDA margin, measuring how effective a firm is in turning their revenue into cash flow. It is a suitable addition to ROA, as it eliminates non-cash expenses such as depreciation and amortization, taxes, and capital structure. As the sample contains a wide variety of industries with different options and possibilities for financing, along with varying degrees of depreciation, amortization, and impairment costs, measuring firm profitability through the EBITDA margin allows me to exclude the effects of all these expenses.

Furthermore, innovativeness should be able to increase sales, and as such, sales growth has been used as a financial performance indicator in an assortment of studies (see, e.g. Coad & Rao-Nicholson, 2010; Lome, Heggeseth, & Moen, 2016; Parasuraman & Zeren, 1983). The effect that R&D and innovation have on sales growth seems to be lagged, as the commercialization of a new, innovative product for example, might take a few years before customers will be able to buy it from the store. This lagged effect has been reported to take approximately two years to be visible in the revenues (Lome, Heggeseth, & Moen, 2016; Pakes & Schankerman, 1984), albeit it is uncertain by its nature, as there is no guarantee of increased future earnings (Pandit, Wasley, & Zach, 2011).

Lastly, by including only publicly listed firms in this thesis, I am also able to analyse firm performance from the market valuation viewpoint. Reflecting back on the last subchapter regarding the inefficiency in presenting intangible assets properly on the firm balance sheet, an appropriate ratio measuring this issue would be Tobin's q. In equilibrium, when the market value fully reflects the balance sheet asset value of the firm, the ratio assumes the value of 1.0. If Tobin's q is less than 1 it would imply market undervaluation of the firm, while overvaluation assumes a value over 1. If the market correctly identifies the value of intangible assets, even those that are not shown on the balance sheet, Tobin's q is expected to show a value over 1. Therefore, the measure of interest will be: does an increased R&D intensity lead to a positive change in Tobin's q?

2.3 Business cycles and recessions

Throughout time, an economy has been anything but stationary, as the constant change in the development and growth has challenged firms to adjust themselves in their competitive environment. Changes in trade opportunities, resource availability, the firm composition within industries, and the regulatory environment compel firms to continually overcome new challenges to ensure the firm survival. More so, the economy as a whole is affected by macroeconomic indicators, such as interest rates, and global trade patterns between nations. Business cycle theory investigates these short-term fluctuations, resulting from the variation in these elementary factors in the economy. This chapter will first present a theoretical backdrop of business cycles, followed by an overview of the recessionary theory. The recessionary effects on both firm investments and firm performance will be discussed in the next chapter presenting earlier research within the field.

2.3.1 Business cycles

Defining what a business cycle is, or what components it consists of, has been a central question during the 20th century. The oldest, simplest and presumably most widespread concept of business cycles is provided by Burns and Mitchell (1946) in their landmark work:

> Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle.

Identifying and measuring these fluctuations in the economy are mainly divided into two dominating methods of measurement; classical cycles and growth cycles. The former is the American standard, developed by the National Bureau of Economic Research (NBER) and based on an assortment of economic indicators in the U.S. economy (Zarnowitz, 1991). The latter is the European standard of a business cycle, measured by comparing an economy's actual GDP to its potential GDP (Snowden & Vane, 2005). Irrespective of the cycle measurement method, fluctuations are usually classified into periods of economic expansion (boom) followed by a period of contraction (recession) (Gärtner, 2006).

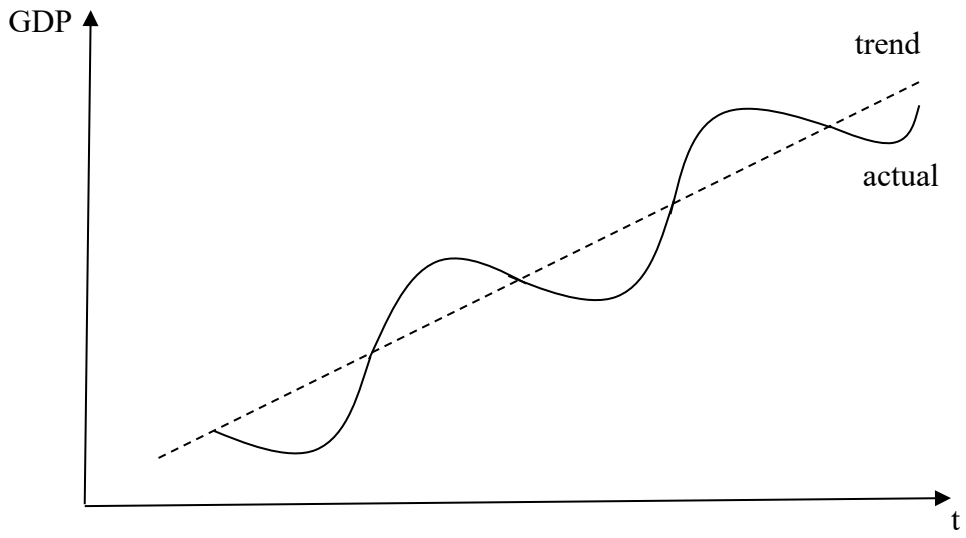

Figure 2.3 Simplified framework of business cycles

To illustrate the concept of business cycles, with respect to the thesis taking a Nordic perspective on the matter, I will present the framework of a growth cycle context.

As depicted in Figure 2.3 above, the GDP level of actual income fluctuates around the general long-term GDP trend that is the potential income of an economy. During times of economic expansion, the actual income exceeds its potential income level, leading to a positive output gap. This phase of expansion lasts until it reaches its peak level, the maximum distance from the long-term GDP trend, thereafter, leading into a phase of a slowdown. In this slowdown phase, the positive output gap diminishes, until the actual GDP equals the predicted long-term GDP trend. Following this, the economy enters a phase of a downturn, where the output gap increasingly becomes negative. This downturn phase lasts until the output gap reaches the trough, its lowest point, ensued by a retrieval phase towards the long-term GDP trend.

Despite the term *cycle*, the different phases in a business cycle may vary in terms of length and severity from time to time, and economy to economy. Zarnowitz (1991) reports that the periods of economic expansion for U.S. post-World War II have varied from one year to ten years, while the periods of recessions varied between merely six and sixteen months. This further implicates that the total length of a full business cycle will vary over time for an economy (Gärtner, 2006).

2.3.2 Recessions

Facing the same dilemma as business cycles, the definition of a recession varies among scholars – the duration and the severity of an economic downturn being the key variables. Gärtner (2006) defines a recession as the phase of a business cycle when actual income is below the potential income, whereas NBER (2010) has a more strict definition of recessions as, "… a significant decline in economic activity spread across the economy, lasting more than a few months, normally visible in real GDP, real income, employment, industrial production, and wholesale-retail sales". Due to the accounting-based viewpoint of this thesis, I will adapt the popularized and simplified definition of a recession described by Shiskin (1974) as "a decline in the seasonally and calendar adjusted real gross domestic product (GDP) in at least two successive quarters".

Not only do recessions affect economies, but they may also purge and reconstruct industries (Latham & Braun, 2011), and critically affect firm performance or even the survival of firms (Geroski & Gregg, 1997). While the cause, length, and severity of a recession may vary, there exist universal elements in most recessions that affect firms considerably. Knudsen and Lien (2014) point these factors out as demand reductions and financing constraints, albeit firms experience them in varying combinations and degrees of severity.

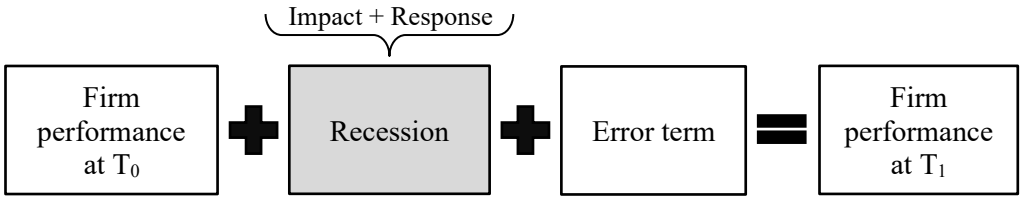

Figure 2.4 Impact of recessions
(adapted from Knudsen & Lien 2014)

Further, by utilising the illustrative model in Figure 2.4, it is possible to measure how a firm's specific response in the event of a recession affects its future performance. In addition to the exogenous shock of a recession, the model includes an error term relating to the factors affecting firm performance in the period, but those that are not related to the recession. To be able to capture some extent of the error term, control variables will

be used in the empirical model for the study. These control variables, together with the empirical model, will be presented in the methodological chapter of this thesis.

3 LITERATURE REVIEW

This chapter will provide insight into prior research within relevant topics to the study. Firstly, prior studies in firm resources and performance will be discussed. Then, further analysis will be provided on firm performance and firm investments in recessions and to conclude, a summarisation of the insights provided by these studies.

3.1 Resources and firm performance

Parasuraman and Zeren (1983) study how R&D expenses related to company sales and profits through a longitudinal study of 310 U.S. firms in 24 industries. The data is based on an annual R&D Scoreboard from the *Business Week*-magazine, including public companies with annual sales of over $35 million and either at least $1 million spent on R&D or an amount of at least 1% of their sales figures. Simultaneous and lagged relationships are analysed in three periods of time; that is, from 1976 to 1980, 1975 to 1979, and 1974 to 1978. In the analysis generally more human-capital intensive industries show persistently higher R&D to both sales and profits correlations, while more labour-intensive industries show relatively lower correlations. Throughout the time blocks, the authors find a more often occurring correlation between R&D expenditures and sales, rather than R&D expenditures and profits – indicating that when evaluating the effectiveness of R&D, sales figures may prove to be more beneficial benchmark.

Morbey (1988) indicates in his all-industry study, consisting of large U.S. companies over the period 1976-1985, that there is a strong association between sales growth and R&D intensity. From the 173 companies in the study, the group with the highest R&D intensity at 4 percent or higher at the start of the period, also presented the highest sales growth. Firms that invested at least 3% of sales revenue on R&D had an 80% chance for growth of at least half the rate of GNP[2] growth. Despite this growth in sales, the results suggest no significant relationship between profitability and R&D intensity. Furthermore, the growth of R&D funding showed a much weaker effect than the effect R&D had on firm

[2] Actual gross national product

growth. There was little evidence of increased profits and growth leading to additional allocations for R&D.

Klette and Johansen (2000) present an improved econometric framework on R&D investments and productivity, that allows positive feedback in earlier acquired knowledge accumulation to be included, rather than the standard model that considers knowledge accumulation equally to accumulation of physical capital. By including this feedback aspect, it might explain the persisting differences in productivity between industries or even countries, and eventual momentum gains and phases of soaring growth within these countries or industries. This is further cultivated by the authors at the micro-level, by analysing large firm-level differences in R&D efforts, as well as these efforts' persistence over time. This persistence might be explained by the positive feedback from prior R&D success to the fruitfulness of ongoing R&D. When analysing their dataset containing Norwegian manufacturing firms, Klette and Johansen find that the applicable part of R&D capital depreciates quite fast, estimating an average annual depreciating rate of around 18 percent. This high rate of depreciation suggests, according to their model, significant spill over effects. Further estimates also present the significant effect of R&D investments on firm performance (or alternatively on plant performance).

Ang and Wight (2009) research the accumulation of intangible resources from the viewpoint of firm reputation and how it affects the financial performance of a firm, based on reputation data from Fortune's annual survey of firm reputation. The reputation of a firm is nearly inimitable, non-substitutable, and one of the least tangible assets according to RBV (Barney J. , 1991), and should as such, offer the greatest potential for firms to create and sustain a competitive advantage if exploited appropriately. The authors find that strong financial performance is critical for a firm to build a strong reputation, whereas a reputation cannot be built by itself; but rather, is a result of a number of activities within a strong financial performance. This strong financial performance is also merely a result of chosen prosperous firm strategies and successful navigation of the surrounding business environment. Further, firms are required to consistently perform well to build a reputation, as firms with consistently superior performance have a stronger reputation than those firms that are less consistent in their performance. This consistency also applied to those firms that consistently performed poorly when compared to inconsistent poor performers, where the former had a worse reputation than the latter. As reputation

is also subjective and relative to competitors' reputations, a firm with a strong reputation can not only enjoy a sustained competitive advantage against current competitors but also eventually discourage potential competitors from entering the market (Ang & Wight, 2009).

Ahmed and Jinan (2011) find evidence for firms' life cycle stages impacting the relationship between R&D expenditures and firm performance. The 321 Australian companies during 1994-2004 in the sample were classified into one of three life cycle stages: growth, mature or stagnant – based on a composite measure consisting of dividend pay-out, sales growth, capital expenditure, and firm age. Results from the single equation multivariate model suggest that there is a significant negative relationship between unexpected expensed R&D amounts and firm performance that is more evident during the stagnant phase of a firm's life cycle. This indicates that the financial markets assume that firms at this phase of the firm life cycle have limited possibilities of fully obtaining the benefits of these expensed R&D costs.

3.2 R&D and innovation in recessions

Dugal and Morbey (1995) study the two recessionary periods of 1981-1982 and 1990-1991 in the U.S., analysing how firms with different degrees of R&D spending performed during these times of economic turbulence. Earlier research during the time of the study had also studied what implications R&D investments have on firm performance, although, during periods of economic growth. The authors examine what effect R&D expenditures had on sales during the 1990-1991 recession, what effects firm- and industry-level variables had on inter-firm differences in R&D spending during this 1990s recession, and finally, comparing these results to the recession of 1981-1982. While the sample of 1982 consisted of 172 large established firms, this amount had sunk to 122 for 1991, due to acquisitions, mergers, and bankruptcies. The R&D intensity level was based on corporate spending on R&D expenses in relation to sales, and average intensity for the four-year period pre-recession was compared to the sales performance during the recession. In their results, of the firms with sales declines during the 1982 recession, 81% spent less than 3% of their sales on R&D. The same applied for 62% of the companies with decreased sales during the 1991 recession. Meanwhile, among the firms that spent more than 5% of their sales income on R&D, 70% had sales increases during the 1981-

1982 recession respectively 74% of the firms during the 1990-1991 recession. This critical level of above 3% R&D intensity to prevent sales declines during a recession was also concluded in an earlier study to be the critical level for ensuring acceptable long-term growth regardless of industry (Morbey, 1988).

Ghemawat (2009) argues that on the impact of a recession, a firm is met with two choices: either to invest and experience a financial risk, or not to invest and, thus, encounter a competitive risk. As a result of a recession, a company might be met with a reduction in the demand for their products or services which, in turn, affects their opportunities to invest for growth, as well as the ability to finance daily operations and new investments. Firms that are more harshly affected by a recession tend to prefer short-term benefits and survival, while those that are not as affected by a recession use the opportunity to acquire under-priced assets in the hope of eventually gaining a competitive advantage in the long term. (Knudsen, 2019) The findings in the study argue for managers underestimating the competitive risk of not investing, as downturns may provide opportunities to acquire assets far below their real value, thus, offering a chance on gaining excess returns (Ghemawat, 2009). Further, sudden belt-tightening on the impact of an economic downturn may cause more harm than good, which supports Hall's (2010) suggestion on the high adjustment costs of R&D investments. Thus, as long as a competitive advantage can be reached cost-effectively, investing to create and maintain a competitive advantage is the best way to manage a firm through an economic downturn (Ghemawat, 2009).

Paunov (2012) study eight Latin American economies during the global economic crisis of 2008-2009 and its effects on the innovation performance of the 1 223 firms in the sample. Research findings show that 25% of the firms halted their investments in innovation projects following the crisis. Constraints in financing played a major role, as firms that had access to public financing were less prone to abandon their innovation investment projects, while young firms had a higher tendency to do so. Further, firms that were either suppliers to foreign multinational corporations or those that had a decrease in export market sales, had also a higher likelihood to end investments in innovation projects (Paunov, 2012).

Knudsen and Lien (2014) were among the first to address the absence of recessions and firm investment behaviour in strategical literature. As the authors point out, these topics have however been included in many studies within the literature of macroeconomics and

finance, with an explicit emphasis on physical investments given how financial shocks affect either product demand or financial constraints (e.g. Fazzari, Hubbard, & Petersen, 1988; Myers & Majluf, 1984). In the paper, the authors further divide firm investments into three categories: physical capital, R&D and innovation, and human- and organizational capital. Depending on the severity of the shock and the combination of the two effects that a financial shock causes, the effect on a firm's investments vary. While the authors emphasize more investment consequences in the event of a recession, these consequences may affect firms negatively in their competitive outcomes for a long-lasting period.

Ratvik and Svergja (2016) study in their master's thesis on how firms' innovation activities impact their performance during a recession, namely, during the recession of 2008-2009 in Norway. The authors apply Norwegian innovation data from the time period 2006-2010 together with accounting data from 2008-2012 while studying innovation activities both before and during the recession. Contrary to the previous and generally positively seen innovation-performance link in research, they find that innovating firms constantly underperformed the non-innovating firms when measuring firm profitability. For the top innovating quartile of the firms, ROA and EBITDA-margins were negatively affected during the recession. Pre-recession innovation had a little and not statistically significant effect on post-recession firm performance, which was also true for innovation done during the recession and later firm performance.

Flammer and Ioannou (2018) study U.S. firms' investments in key strategic resources and how these investments were adjusted in response to the Great Recession of 2007-2009. These strategic resources include R&D, capital expenditures, workforce, and lastly, CSR[3]. When measuring firm performance post-crisis, and how the firms adjusted their investments during the crisis, companies that reduced neither their workforce nor their capital expenditure did not show better performance post-crisis. Meanwhile, those companies that did not reduce their investments in R&D and CSR achieved significantly better performance post-crisis, with a 19% respective 10% higher ROA, when compared to those companies that did reduce their investments in these resources. In their findings, the companies that responded to the financial crisis by reducing both workforce and

[3] Corporate Social Responsibility

capital expenditures, while sustaining their investments on CSR and R&D, demonstrated the highest performance in the post-crisis period.

Sun, Lee, and Phan (2018) research firm investments in the 2008-2009 financial crisis from the perspective of family firms, compared to those firms that are not family-owned. The study was conducted in the U.S., where these family firms have an immense contribution to the country's economy, as the firms not only contribute 64% of the GDP but also account for nearly four-fifths of the new jobs created. Their results showed that non-family and family firms tend to behave differently when facing economic distress, where the latter group saw external threats as opportunities for risk-taking when having excess funding available for usage. Although, approximately only one fifth of the family firms were financially unconstrained, while the same number for the non-family firms was nearly one-third of the firms. Therefore, there are indications that non-family firms have better access to capital markets, as the family firms also showed higher levels of cash and lower leverage, by chance to abstain from borrowing at a higher interest rate. No differences in investment behaviour were found when comparing financially constrained family and non-family firms R&D investments, whereas the differences between the two firm types arose when comparing unconstrained firms. The authors imply that these results could indicate family firms' higher willingness to engage in longstanding investments during downturns in the business cycle (Sun, Lee, & Phan, 2018).

In their most recent paper regarding investments in recessions, Knudsen & Lien (2019) examine alterations in Norwegian firm investment behaviour, as a response to changes in demand and credit access caused by recessions. Findings imply that investments in both physical assets and R&D are negatively related to the two types of shocks a recession causes; that is, demand reductions and credit constraints. The negative effect of a demand reduction for physical investments was approximately threefold in comparison to R&D investments, while a reduction in credit access gave roughly equal effect on both investment types. Facing momentary fluctuation in demand, the firms displayed a tendency of shielding R&D investments, although also showing a higher sensitivity to credit changes than generally assumed. Additionally, investments in human capital were independent of reductions in credit access, but changes in demand showed a cubic pattern in relation to human capital investments. Small reductions in demand caused firms to

increase investments in human capital, while strong demand reductions reduced these investments. Similarly, when experiencing a minor increase in demand these investments stayed constant and large increases in demand caused a rise in human capital investments (Knudsen & Lien, 2019).

3.3 Firm performance in recessions

Geroski and Machin (1993) examine what effects innovation has on corporate performance in the UK, by utilizing a unique dataset containing major innovations produced and used over the time period 1945-1983. The innovativeness of each firm was of interest, and by using this dataset the firms were divided into two groups of firms, innovating and non-innovating, based on if the firm managed to produce a major innovation during the examined time period. By comparing the twofold effect of innovation – "*the product view*[4]" and "*the process view*[5]" – the authors find evidence of both effects in the data. Even though some single innovations had a positive effect on profitability and growth, it seems that the process of innovation itself transforms firms in a specific way, causing a general difference between the non-innovating and innovating firms. Further, the most noticeable difference between these non-innovating and innovating firms was that the latter were considerably less sensitive to cyclical shocks than the former. Geroski and Machin (1993) argue that this is due to innovating firms being more adaptable and flexible, with internal capabilities to respond quickly to exogenous changes, whether that is new developments in technology or changes in the business environment due to economic downturn.

Earlier research has shown the absorptive capacity of *slack resources*[6] in the event of exogenous shocks in the economy (Bourgeois, 1981; Cheng & Kesner, 1997), resulting in better firm performance during an economic downturn. Latham and Braun (2008) research what implications slack resources, especially financial slack, had on firm performance in the event of economic recession and recovery period. Here financial slack was described as the difference between the working capital available to a company and the required working capital, where a higher ratio indicated ineffective usage of excess resources. The setting for the research was the period of 2001-2003, studying a sample of

[4] Innovating a new product, a new feature or enhancing an existing product feature
[5] Innovating e.g. the process of manufacturing or delivering a product/service
[6] Availability of a resource, consider as opposite to resource constraint

450 companies in the software industry of the United States. The results in the study imply that firms with a higher degree of financial slack experienced worse performance than their counterpart, possibly due to slower reaction time to the beginning of a financial shock. However, this higher degree of slack also enabled better withstanding to a continued period of economic downturn or allowed these firms to shift excess resources into strategic investments during economic scarcity. Further findings showed that firms with heavy investing in R&D had a more rapid decline in firm performance, measured as ROA than firms with a lower intensity. Admittedly, the sample included many start-up firms with high R&D spending compared to their revenue, eventually leading to disproportionality in the R&D/revenue-ratio by the demand shocks. Meanwhile, these more intensely investing firms also demonstrated a faster rate of recovery in the wake of a recession, as the firms might have gained a competitive position on the market when the demand for information technology rejuvenated.

Considerable investments in R&D might also offer firms improved performance during financial crises, compared to counterparts that do not invest as heavily in R&D. According to Lome, Heggeseth, and Moen (2016) this was the case for Norwegian manufacturers during the financial crisis of 2008-2009. The study covers the period of 1999-2009, analysing 247 Norwegian SMEs[7] through data on financial performance and a survey that was distributed to managers of these firms in 2004. When grouping the firms into three groups based on R&D intensity, the ones investing heavily into R&D presented growth in revenue over 3.5x as much as the ones with a low intensity during 2004-2009. Further, the authors imply there is a two-year lag on R&D spending prior to resulting in the revenue stream, which is within the 1.17-2.40 years' time lag found in earlier studies (Pakes & Schankerman, 1984; Rapoport, 1971). Lome et al. (2016) also discuss the eventual causes for this result in differing performance due to R&D investments and highlight R&D's positive effect on firm's absorptive capacity (Cohen & Levinthal, 1990; Griffith, Redding, & Van Reenen, 2003), which also presumably contributed to the greater performance of the R&D-intense firms throughout the economic turmoil.

Nason and Patel (2016) examine how firm holdings in cash affect their performance during a recession, as earlier research into the matter has been based on times of stable economic conditions. By analysing a sample of publicly traded U.S. manufacturing firms

[7] Small and medium-sized enterprises

in the period of 2004-2010, the authors aim to study if the stock market values firm cash holdings in a period of economic downturn. Based on earlier research (Kim & Bettis, 2014), the chosen dependent variable for measuring firm performance was Tobin's q, measured as the total market value of the firm divided by total assets. The results show that the benefits of cash during recession decline at medium levels of cash holdings, 0.4 of total assets, while the same ratio for pre-recession is as high as 0.9 of total assets. When further testing the model with ROA as the measure of performance, despite finding ROA being lower during a recession, the authors do not find a significant effect of cash on ROA during a recession. This difference in the result was interpreted as a difference in market-based measures compared to accounting-based measures, where the main findings are to be interpreted in line with market-based performance, as it is forward-looking compared to the past-oriented accounting measures (Nason & Patel, 2016). In summary, the stock market appreciates firm cash holdings up to a certain level when measured with Tobin's q, both pre-recession and during a recession, albeit to a lower level for the latter period.

Burger, Damijan, Kostevc, and Rojec (2017) investigate sources for firm performance and growth during the financial crisis of 2008-2009 in the corporate sectors of the Central and Eastern European countries (CEECs). These, at the time, new EU member states were hit far harder than most of the old EU member states, as the total value added of non-financial corporate sectors decreased by 10.4 percentage points for CEECs during 2008-2010, compared to the average of merely one percentage points decrease in old EU member states. The causes for this difference are manifold, as the authors uplift CEECs being in a distinguished boom period before the crisis and the economic fundamentals being less robust than in the old EU member states, as some of the reasons behind this worse performance. As for the panel VAR analysis of factors, which may affect a firm's resistance to economic distress, these were: firm size, firm age, firm's export propensity and source of ownership, whether it is domestic or foreign. Burger et al. (2017) find small young firms to react faster to cyclical shocks by reducing employment, whereas exporting firms and foreign-owned firms had a more stable number of employees. Firm investments did not react to demand shocks, but rather to the component of free cash flow during the business cycle. Young firms were the ones to react most to a financial shock, while small old firms were the least responsive when measuring their investment activity. Also, exporting firms had a more stable investment activity when compared to non-exporting firms, and foreign-owned firms showed the same trend, compared to domestic firms.

In their master's thesis, Vethe and Hage (2018) study the impact of cash holdings on firm performance in Norwegian companies – in general, as well as for the period of an economic downturn. According to the resource-based view (Barney J. , 1991), financial assets such as cash are easily imitable and commonly available to competitors; therefore, it should not be considered as a source of sustained competitive advantage for a firm. Despite this, the authors prove cash having an effect on firm performance, although their sample of Norwegian firms' performance were being less affected by cash than U.S. manufacturing firms' performance were in the study of Nason and Patel (2016). Throughout the studied time period, cash had a positive, albeit weakly diminishing effect on firm performance and the effect was most evident before the recession. The effect being the most prominent pre-recession corresponds with the business cycle theory, as an expansion period often precedes a recession. Firm performance could be affected negatively by having high cash reserves during an economic boom, as the opportunity cost of not investing increases (Vethe & Hage, 2018). Further, the authors find that firms with a higher level of knowledge intensity hoard more cash than less knowledge-intensive firms, and that capital-intensive firms hoard less cash than labour intensive firm. Lastly, Vethe and Hage (2018) emphasize that the deployment of cash is vital, when examining if cash is to be valued as a firm-specific strategic asset. Cash itself does not generate value, but it allows firms to obtain, grow, and develop strategically important resources that may impact firm performance.

Knudsen (2019) suggests that differences in pre-recession characteristics of firms may answer why recessions impact some firms worse than others. The study was based on Norwegian companies, combining a unique survey about the firms' viewpoint on how the financial crisis of 2008 affected them, along with accounting data from the subsequent years of recession. The paper presents high pre-recession market growth as one primary influential factor that causes demand problems during a recession. Also, firm strategies emphasizing on quality led firms to be more severely struck by a financial shock. Additionally, firms that prioritized low-cost strategies and those that had been investing generously into innovation were in a more advantageous position in the wake of a recession.

Giebel and Kraft (2019) find in their study that innovative firms are more likely to have more severe consequences of a financial crisis than non-innovative firms, when

interpreting innovativeness as introducing product(s) new to the market (cf. Lee, Sameen, & Cowling, 2015). Like related research articles (Campello, Graham, & Harvey, 2010; Knudsen, 2019), the authors use here a combination of a questionnaire-based assessment on the financial crisis' impact on firms, together with accounting data for the firms. The data is acquired from the IAB Establishment Panel, for the time period of 2006-2010 and consists of close to 16 000 firms in Germany. Although the results of the study contradict Knudsen's (2019) findings, the authors here imply the negative effects of a financial crisis as credit constraints. Also, different types of investments were not distinguished, resulting in no differentiation between intangible assets that are preferably financed with internal capital (Czarnitzki & Hottenrott, 2011; Myers & Majluf, 1984; Ughetto, 2008) and pro-cyclical physical investments (Aghion, Askenazy, Berman, Cette, & Eymard, 2012). Admittedly, financial constraints still also affect R&D negatively (Mancusi & Vezzulli, 2010; Paunov, 2012), albeit it being an intangible asset.

3.4 Hypotheses development

Having established a theoretical backdrop of sources for firm performance; research & development implications on accounting and firms; business cycles and recessions, as well as empirical evidence on how recessions impact R&D spending and firm performance, I can develop hypotheses on how recessionary R&D spending affects firm performance.

First, there seems to be a generally agreed positive relationship between R&D activities and firm performance. It is the source of new product innovations and improved processes that enables further firm growth in this increasingly global and technological world. For this reason, it can also be seen as a necessity; if your firm does not innovate, your competitors will and you risk losing the competitive edge against them.

When adding the business cycle viewpoint on R&D activities in relation to firm performance, results begin to vary among academics. Some studies find that innovative firms are hit harder by the recession than non-innovators (Giebel & Kraft, 2019; Ratvik & Svergja, 2016), while other find that innovative firms survive the recessionary period better than their counterpart (Geroski & Machin, 1993; Knudsen, 2019; Lome, Heggeseth, & Moen, 2016). It is therefore of interest to examine if there is a significant

relationship between R&D activities pre-recession and firm performance during the recessionary time period:

Hypothesis 1

H_0 = There is no relationship between R&D activities pre-recession and firm performance during the recession

H_1 = There is a relationship between R&D activities pre-recession and firm performance during the recession,

and whether this effect is either positive or negative:

H_{1a} = There is a positive relationship between R&D activities pre-recession and firm performance during the recession

H_{1b} = There is a negative relationship between R&D activities pre-recession and firm performance during the recession.

Latham and Braun (2008) find for example that while the R&D-intensive companies suffered a more rapid decline in ROA when the recession hit, the firms also exhibited faster growth than their counterparts after the recessionary time period.

As the R&D activities are closely tied to the human capital of the firm, firms tend to smooth out R&D spending due to high adjustment costs (Hall, 2010). During recessions, Knudsen and Lien (2014) point out credit constrains and demand reductions as the main effects that firms suffer, which can be argued to affect the firm's ability to finance its operations and ongoing investments. Due to the aforementioned high adjustment cost of R&D projects, firms tend to shield these from temporary demand shocks such as the ones during recessions (Knudsen & Lien, 2019). As the R&D spending is preferably internally financed (Czarnitzki & Hottenrott, 2011), those firms that are not able to upkeep spending might face involuntary cuts in their R&D activities, causing possible lasting disadvantages compared to their competitors. Thus, could recessionary R&D intensity affect later firm performance, even several years after the recession?

To examine this, my second hypotheses is whether the R&D intensity, measured in relation to total sales and total assets, during the recession has a significant relationship with later firm performance:

Hypothesis 2

H_0 = There is no relationship between the intensity of R&D during the recession and later firm performance

H_2 = There is a relationship between the intensity of R&D during the recession and later firm performance,

and whether this effect is either positive or negative:

H_{2a} = There is a positive relationship between the intensity of R&D during the recession and later firm performance

H_{2b} = There is a negative relationship between the intensity of R&D during the recession and later firm performance.

As a variation of this hypothesis, would there be a difference between firms that increase their R&D spending during recessions, compared to those that do not? As Knudsen and Lien (2019) point out, firms may adopt a countercyclical strategy when demand reductions lead to excess capacity, albeit to a certain level. This excess capacity is then used to stimulate human capital investments, which also happens when firms experience high demand increase, as during years of economic boom.

This leads into the final hypothesis of this thesis: is there a relationship between increased R&D intensity and later firm performance when compared to the firms that decrease their R&D intensity?

Hypothesis 3

H_0 = There is no relationship between increasing the intensity of R&D during the recession and later firm performance

H_3 = There is a relationship between increasing the intensity of R&D during the recession and later firm performance,

and whether this effect is either positive or negative:

H_{3a} = There is a positive relationship between increasing the intensity of R&D during the recession and later firm performance

H_{3b} = There is a negative relationship between increasing the intensity of R&D during the recession and later firm performance.

To test for these hypotheses, I will adapt different analysis methods with a variety of different variables. The following chapter 4 will explain the methodology of this thesis in detail, while the results will be presented in chapter 5 and discussed thoroughly in chapter 6.

4 METHODOLOGY

In this chapter, the research method, empirical context and data for this thesis are presented. This will be followed by an introduction of the variables chosen for the study. Then, theoretical background will be provided regarding the regression analysis and the non-parametrical test. Lastly, concerns regarding data and the validity of the study will be discussed.

4.1 Research design

Bryman and Bell (2011) determine that a research purpose may be exploratory, descriptive, or explanatory. The research question in this thesis attempts to investigate the relationship between differences in firms' R&D activities during recessions and differences in the firms' later performance, thus including all three aspects listed. Although, as the aim of the study is to discover a causal relationship between R&D activities and firm performance, the research purpose of this thesis is explanatory.

The approach for research within the business and economic studies generally is either inductive or deductive (Bryman & Bell, 2011). If an inductive approach would have been used in this study, gathered data would have been used to develop theories. As this study uses existing theories, prior research, and empirical observations, it will befittingly to the explanatory purpose adopt a deductive approach (ibid.).

4.2 Empirical context

To offer further insight into the time period of interest in this study, this subchapter will present the impact of the Great Recession of 2008-2009 on the Nordic countries that are chosen for this study. In addition to the larger macroeconomic picture, the research and development activities of these two countries are shown, discussing the similarities and differences between the countries.

4.2.1 Recessionary impact on Finland and Norway

The financial crisis of 2008 began, in fact, a year prior as in February 2007 some subprime mortgage lenders began reporting losses. During the following year and a half there were indications of a possible upcoming financial crisis, as negative revelations related to the

credit default swaps (CDS) consisting of subprime loans were discovered. In August 2008, however, the sudden bankruptcy of the investment bank Lehman Brothers caused a full-scale panic on the financial markets, resulting in the financial crisis that led to the Great Recession of 2008-2009 (Duchin, Ozbas, & Sensoy, 2010).

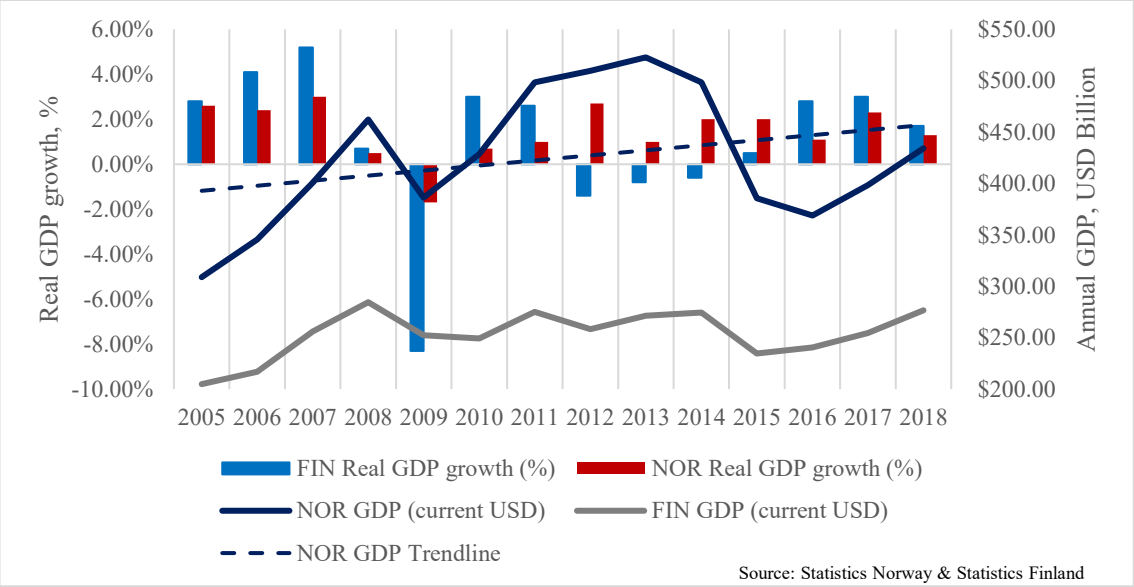

Figure 4.1 NOR & FIN GDP, 2005-2018

Viewed from a macroeconomic perspective, Figure 4.1 above shows that the real GDP growth of Finland and Norway barely stayed positive in 2008 as the full-scale global market crash hit in September. The following year depicts the difference in how the economies suffered due to this crisis, as the real GDP growth for Finland plunges to -8%, while it decreases for Norway only to -1.7%. Still, while this dip in GDP growth for Norway was not as extreme as that of Finland, Norwegian firms were nevertheless severely affected in their growth and profitability (Knudsen & Lien, 2019).

In 2010 and 2011 the GDP growth turned yet again positive for both countries, whereas differences arise during the period from 2012 to 2014. During these three years, Finland is technically in a recession, whilst the Norwegian economy is experiencing annual growth in GDP. It was during this period that the European debt crisis happened, causing uncertainty on the markets due to the inability of some eurozone members to pay their government debt. Lastly, from 2015 to 2018 both countries boast positive real GDP growth, ending the study period with anticipated positive firm performance. Examining Figure 4.1, it can be seen that the Finnish real GDP growth depicts quite befittingly the earlier discussed business cycle, showing clear periods of economic expansion and

downturns. For Norway, this cyclical nature is not as clearly illustrated during this relatively short 11-year period.

The focus of this thesis, however, is not studying why these differences arise between the countries, so they won't be discussed in further detail. It is still of importance to recognize the practical differences between these two countries in the study, as these country-specific effects may severely affect analysis results throughout these 11 years examined. How this is controlled for in the regression models, will be shown in chapter 4.4.3 that discusses the control variables used in the analyses.

4.2.2 R&D investments in Finland and Norway

Reported by the European Innovation Scoreboard of 2019, among the four leading EU member states regarding innovation are three Nordic countries: Sweden, Finland, and Denmark (European Comission, 2019). As Norway is not included among the EU member states, it is not included in the report. The heavily oil-based country, however, is no stranger to innovating activities, as the OECD countries follow innovation reporting guidelines known as the Oslo Manual. Norway is also, due to this high dependency to the oil- and other resource-based sectors, facing a transition towards a more diverse economy, emphasizing the need of strong research and development activities in the society as a whole (OECD, 2017).

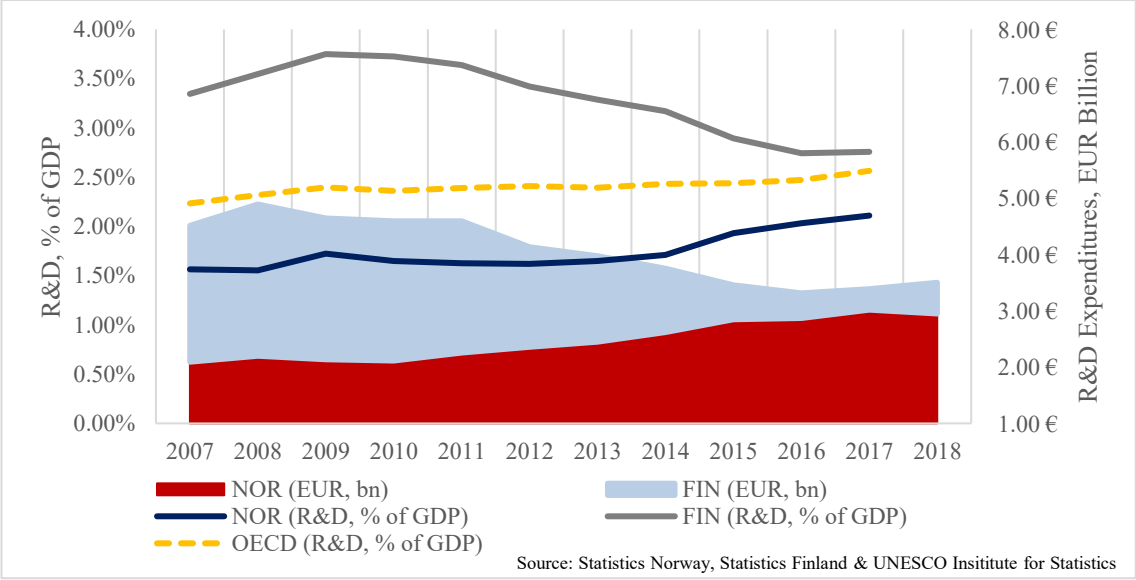

Figure 4.2 NOR & FIN R&D spending, 2007-2018

In Figure 4.2 above, the R&D expenditures for both countries spanning from 2007 to 2018 can be seen from different perspectives. On the right-hand scale the R&D spending

of the business sector of respective countries is shown in billion euros. The figures for both countries are adjusted for country-specific inflation before transforming NOK into EUR for comparison. Inflation percentages and currency exchange rates are found in Appendix 2. respective Appendix 3. On the left-hand scale, R&D spending is measured as a percentage of the Gross domestic product (GDP), including the average for the 35 OECD countries as well. This percentual R&D spending includes all R&D activities done in the country, within the public sector, the business sector as well as research institutes and universities.

While one of the indicators depict the evolution of R&D spending from a broader perspective, and the other one from a narrower point of view, both illustrate the same trend: the gap in R&D spending between the countries has narrowed during the last decennium. Finland peaked in R&D expenditure around the recessionary years of 2008-2009, while Norway has quite steadily increased its efforts within research and development, at least when viewed purely from the spending point of view.

4.3 Data

The following chapter will first describe the data selection process, the selection criteria for the sample, the differentiation between the different time periods, and the industry classification system. Then, it will present the different biases the sample might suffer from and their eventual consequences. Finally, it will present the data treatment process, how the observations were filtered, the removal of outliers, and other effects that would affect the analysis results.

4.3.1 Selection of data

The selected Nordic data for this thesis is based on listed firms from Finland and Norway. The research sample was collected from the listed firms in the Helsinki Stock Exchange (OMXH) and the listed firms in the Oslo Stock Exchange (OSE). Only companies that were still publicly listed in December 2018 on the main list of the stock exchanges were included in the study. This initial sample consisted of a totalling 326 companies, of which 130 were Finnish and 196 were Norwegian companies. I will use Microsoft Office Excel 2016 for compiling and treating the data for outliers, while IBM Statistical Package for the Social Sciences (SPSS) Version 26 will mainly be used to analyse this data.

Data collection process

The data for the companies was collected from various sources, as a single solution for gathering all the data was not available. For the Finnish companies included in the initial sample, accounting data was collected mainly using the Voitto+-software, along with verifying these figures and supplementing the missing values from the companies' financial statements. For the Norwegian companies, accounting data was collected purely from the companies' financial statements.

Share price data was gathered from Nasdaq Nordic for the Finnish companies, also verifying the reported year-end share price figures in the financial statements. Outstanding share amounts were found in the financial statements as well. For the Norwegian companies this data was not as easily available, as the Oslo Stock Exchange only provides stock price development for the last 5 years. Therefore, while most of the Norwegian companies reported their year-end share price in the financial statements, some companies were missing this data. This share price data was then gathered from Yahoo Finance and Reuters, followed by cross-checking with each other for further verification of the accuracy of the data.

The accounting data gathered consists of the fiscal years from 2007 to 2018. The fiscal year of 2007 is considered as a pre-recession period, 2008 to 2009 as the recessionary period and 2010 to 2011 as the post-recessionary period. Reflecting on Figure 4.1, the fiscal years of 2012-2014 could be considered a period of recession for the Finnish companies, while Norway maintained a positive GDP growth during this time period. For the remaining years from 2015 to 2018, both countries boasted a positive GDP growth, thus, being a period of post-recession. At this point, several companies did not have accounting data available to the starting year of 2007 for the analysis, due to various reasons. Some of the listed companies had only been established after the recession of 2008-2009, while some had listed themselves merely a few years before 2018 and therefore, not being obliged to provide financial figures dated to 2007 in their Initial Public Offering (IPO) prospectus.

Following the gathering process of accounting data, further filtering on the dataset was done through different selection criteria. Firstly, the 2008 and 2009 financial statements of the remaining companies were examined, to ensure that the company had ongoing

R&D activities during the recessionary period. Companies missing this data were immediately excluded from the sample. Also, the only company that did not match their fiscal year with the calendar year, like the remaining sample, was left out.

Industry classification

The remaining firm sample was then split into different industries, based on the Industry Classification Benchmark (ICB)-codes that were found on the Nasdaq Nordic website. FTSE Russell is the responsible organisation for maintaining the ICB-system and the classification process of the companies (FTSE Russell, 2019). The ICB-system consists of 10 main industries (1-digit) that are divided first into 18 supersectors (2-digit), followed by 41 sectors (3-digit) and finally, 114 subsectors (4-digit). On the Nasdaq Nordic website, these publicly listed companies are reported on a 2-digit accuracy, which will also be used in this thesis.

While all of the Finnish companies had their ICB-codes listed, merely 20% of the initial Norwegian firm sample had their classification information available on Nasdaq Nordic. With the filtered firm sample, 16 of the 26 remaining Norwegian firms were missing an ICB-code. These were manually added into a befitting sector, based on their financial statements and the publicly available information about the companies. From the Finnish company sample, Fortum was changed from being the sole representative of code 7500 "Utilities" to being part of code 0500, the "Oil & Gas"-supersector. A closer examination of the total included sample in the study, along with the manually adjusted ICB-codes can be found in Appendix 1.

Code	Industry	Supersector	Number of Firms
0500	Oil & Gas	Oil & Gas	7
1300	Basic Materials	Chemicals	2
1700	Basic Materials	Basic Resources	8
2300	Industrials	Construction & Materials	6
2700	Industrials	Industrial Goods & Services	23
3300	Consumer Goods	Automobiles & Parts	2
3500	Consumer Goods	Food & Beverage	7
3700	Consumer Goods	Personal & Household Goods	5
4500	Health Care	Health Care	6
5500	Consumer Services	Media	4
6500	Telecommunications	Telecommunications	3
9500	Technology	Technology	17
Total			**90**

Table 4.1 Industry classification of the sample

In Table 4.1 above, we can examine the final 90 firm sample in the study, consisting of 64 Finnish companies and 26 Norwegian companies. This results in 12 176 observations for the analysis, from which outliers will still be removed.

Potential biases in data

It can be noted that this final sample data may contain biases that are described below. These biases may affect the analysis outcomes shown in chapter 5 and therefore, need to be considered when interpreting the results.

The first bias originates from the issue that all firms that partake in R&D activities, in fact, do not report R&D spending in their financial statements. Companies may report their expensed research costs as part of other operating expenses, as R&D costs consist mainly of payroll expenses. This leads to the sample of firms with reported R&D activities being smaller than the actual population engaging themselves in R&D activities. Albeit these companies are assumedly low R&D-intensive firms, their inclusion would have increased the already small final sample of firms for the analysis and thereby, increased the validity of the study.

An additional problem is the possible survivorship bias in the data. This bias occurs when firms that have bankrupted no longer exist in the data, resulting in a skewness to the right when only including companies that have survived throughout the time period of the study. Survivorship bias can be reduced by using delisting data of the stock exchanges, as Chan et al. (2002) used in their study on the U.S. stock market. This delisting information was not included in the data collection process of this thesis.

4.3.2 Data treatment and outliers

Treating for inflation and currency

In order to make the annual accounting data throughout the time period comparable, it has been adjusted for inflation for both the Norwegian and Finnish companies. The process for the Finnish companies was simple, using 2007 as the base year and adjusting the reported financial figures by an adjustment factor each year in regard to the annual inflation. The annual inflation is calculated from the Consumer Price Index (CPI)

provided by Statistics Finland, along with the adjustment factor can be found in appendix 2.

For the Norwegian companies, this adjustment for inflation required a more complex process. According to the Norwegian Accounting Act (Regnskapsloven) § 3-4., companies may in their annual reports present their financial figures in the currency that their business is mainly related to, also described as "functional currency" (Finansdepartementet, 1998). While most Norwegian firms in the sample used NOK as their currency for reporting, one firm used EUR, and some used USD, which were mainly companies from the Oil & Gas-sector. As the companies were still listed on the Oslo Stock Exchange, the quoted stock prices and the calculated market capitalisation were in NOK. Therefore, to be able to provide accurate financial ratios for these companies, the financial figures in foreign currency had to be transformed into NOK.

The process began by searching for both the annual average exchange rates of NOK into USD and EUR, as well as the year-end exchange rate. These exchange rates were provided by the central bank of Norway (Norges Bank) and are presented in greater detail in Appendix 3. Stated in the Finnish Accounting Act Chapter 6 section 6 (13.7.2011/629) "Balance sheet items… shall be translated into Finnish currency for the purposes of consolidation using the exchange rate at the balance sheet date. Profit and loss account items shall be translated using the average exchange rate for the financial year." (Ministry of Economic Affairs and Employment, 2017). This method of currency exchange rate transformation will also be adapted for the Norwegian firm sample. Thereby, the figures in the income statements were transformed into NOK based on the average annual exchange rate, while those in the balance sheet were transformed in accordance with the exchange rate on the balance sheet day. Lastly, all the figures were adjusted for inflation based on the CPI reported by Statistics Norway, with 2007 as the base year as well.

Sample outliers

Chatterjee and Hadi (1986) define an outlier as an observation with an abnormal distance to the mean and whose exclusion would significantly affect regression results. These abnormal observations should still not be treated as a negative factor affecting the sample data, as they may provide valuable insight. Thus, as the data sample is treated, the main goal is to remove as few outliers as possible; thereby, maximizing the external validity of

the analysis results. This leads into the predicament of a trade-off between deleting observations that could offer valuable information in the regression model or including outlier observations that are negatively affecting the regression model; therefore, risking possible bias in estimation.

Outliers originate either from errors in the data, resulting in unusual observations, or they are extreme values that are caused by natural and logical reasons (Barnett & Lewis, 1978). There are two main procedures that may be used when choosing to treat outliers. The first alternative is to simply use a variety of statistical techniques to objectively remove those extreme value observations that are deemed as outliers. The second approach is to define specific qualitative boundaries for key variables used in the study and then remove the observations that exceed these limiting values. Both methods have their benefits and drawbacks, when considering which method to apply. While the first method offers an objective, purely statistical approach to remove abnormal observations, it can be argued to lead to the removal of observations that should actually be included in the data. The second method, however, while offering an approach to remove outliers based on earlier academic research and to one's best knowledge, requires arguably more effort to conduct properly. Determining relevant boundaries for the key variables require manually checking for outliers, as the goal is to remove as few observations as possible from the already small dataset. This is done by utilising scatter plots on the key variables as an effort to identify eventual extreme value observations.

This qualitative method for identifying and removing outliers was used in unison with a statistical method, as it was found as the most appropriate way to handle extreme values affecting the results of the analysis. The statistical choice of method was Cook's Distance, which was used after conducting the qualitative filtering approach on the variables. After generating a multitude of scatter plots for the key variables, the final cut-off values were chosen as criteria are listed in Table 4.2 below. For further insight into how these qualitative boundaries affected the key variables, the pre- and post-distribution scatter plots are shown in Appendix 4.

Return on Assets (ROA)	>	200 %
Return on Assets (ROA)	<	-100 %
Sales Growth	>	250 %
Sales Growth	<	-100 %
EBITDA Margin	>	100 %
EBITDA Margin	<	-100 %
Tobin's q	>	5
R&D/Sales	>	200 %
R&D/Total Assets	>	100 %
Debt Ratio	>	150 %
Cash Ratio	>	100 %
Fixed Assets Ratio	>	100 %

Table 4.2 Outlier cut-off values for key variables

After removing extreme values that existed beyond these boundaries, the aforementioned 12 176 observations are reduced into 12 028 firm year observations.

Cook's distance

This influence measure was proposed by Cook (1977) and it assesses the influence in regression models by combining the residual and the leverage of an observation. As mentioned, outliers are observations that have high residuals and result from erroneous data or simply odd, extreme values. Leverage then again displays the distance of an independent variable from its mean. Higher leverage, therefore, leads to a greater effect on the regression coefficient estimates. Cook's distance measures the influence of the *i*th observation, and it can be expressed as (Chatterjee & Hadi, 2012):

$$C_i = \frac{\sum_{j=1}^{n}(\hat{y}_j - \hat{y}_{j(i)})^2}{\hat{\sigma}^2(p+1)}, i = 1,2, \dots, n.$$

Which can be translated into

$$C_i = \frac{r_i^2}{p+1} \times \frac{p_{ii}}{1-p_{ii}}, i = 1,2, \dots, n,$$

where

r_i = standardized residual p = number of coefficients

p_{ii} = leverage of the *i*th observation.

The first term is a representation of the observation residual and the second term represents the leverage of the observation; if the observation is influential, deleting it results in considerable changes and increases the value of C_i. The higher value C_i assumes the greater influence of the *i*th observation has on the model.

When adopting the model for removing outliers, the cut-off values for leverage, and the tolerated observation distance need to be determined. This threshold has been met with differing opinions among academics, with Cook (1977) assuming values greater than 1 as influential points (Chatterjee & Hadi, 2012). McDonald (2002) suggests that the threshold should be related to the number of independent variables in the regression model. With 2 regression parameters C_i>0.7, 3 regression parameters C_i>0.8 and exceeding 3 parameters, C_i>0,85, given the number of observations in the dataset exceeds 15. This latter threshold would result in a higher amount of observations removed from the even now small sample and therefore, I will adapt the original and more conservative approach of using values exceeding 1 as points of influence. As Chatterjee and Hadi (2012) also suggest, I will analyse the observations graphically in scatter plots, as I generate Cook's D values annually for the regression models.

4.4 Variable descriptions

This section will present the appropriate variables for developing a suitable research design for empirical analysis. The dependent and independent variables will be established first with a discussion regarding the motivation behind choosing these specific variables. Then, the control variables for the study will be introduced, as these will play a vital role in reducing the unexplained variation that is affecting the assumed effect R&D activities have on firm performance.

4.4.1 Dependent variables

The focus of this analysis is on the financial performance of the firm and its relation to the R&D activities it performs during a recession. Therefore, the dependent variables in this study are metrics that measure financial performance from different viewpoints. I consider these four indicators to give the widest perspective on firm performance, as they measure effects on the top line, operating efficiency, bottom line, and lastly, market valuation.

Sales growth

As found in earlier research, the successful generation of innovative products and services could offer firms possibilities to increase their revenue in the future. I will test for this proposition by measuring a percentual change in revenue on an annual level.

$$Y_1 = Sales\ Growth\ = \frac{(Sales_{t1} - Sales_{t0})}{Sales_{t0}}$$

This variable is expected to react strongly when the recession hits, as demand shocks impact most industries. It is of interest if pre-recessionary R&D activities mitigate or aggravate this effect and at a later point, if those that conduct a higher degree of R&D intensity during the recessionary period, actually have an impact on their later revenue growth development.

EBITDA margin

The second variable offers further insight into the firm's ability to generate cash from its sales figures. Acquiring the ratio, I divide EBITDA with the annual revenue figure.

$$Y_2 = EBITDA\ margin\ = \frac{EBITDA}{Sales}$$

As this thesis focus does not align with tax, capital structure, or asset-level effects, EBITDA was preferred to operating profit, EBIT. Most companies did not include EBITDA in their financial statements, so depreciation and amortization costs were manually added to the operating profit figure before calculating the EBITDA margin.

Return on Assets

In order to measure how well the firm is able to able to generate profitability in relation to its total assets, I will use Return on Assets as one additional indicator of financial performance.

$$Y_3 = Return\ on\ Assets\ (ROA) = \frac{Net\ Income + Interest\ Expenses}{Total\ Assets}$$

While the ratio is a popular choice within finance and accounting research, it does impose a challenge as the capital structure of the firm affects it. This is adjusted for by adding interest expenses on top of the net income, to mitigate the capital structure effect.

Tobin's q

Tobin's q will be defined as an approximation, as shown in Chung and Pruitt (1994):

$$Y_4 = Tobin's\ q = \frac{Market\ Value\ of\ Assets}{Replacement\ Value\ of\ Assets} \approx \frac{MV\ (Equity) + MV\ (Debt)}{BV\ (Equity) + BV\ (Debt)}$$

$$\approx \frac{MV\ (Equity) + BV\ (Debt)}{Total\ Assets}$$

where

$$Equity\ Market\ Value = Current\ Market\ Price\ (per\ share) * Total\ number\ shares\ outstanding$$

As mentioned in chapter 2.2.3, Tobin's q is a measure that assumes that the market value of a firm's assets matches the replacement value of these said assets. The replacement value of the assets is in its simple form, the total assets of the firm. Assuming the book value of debt for example, is considered much harder, and therefore, it is in its simplest form defined as the total liabilities mentioned on the balance sheet. As all the accounting data is adjusted for inflation, the equity market value, also known as the market capitalisation, has been adjusted for this as well.

4.4.2 Independent variables

Next, I present the independent variables that will be the main focus of this thesis. In order to investigate how R&D activities affect firm performance, I have gathered R&D accounting figures from the financial statements of the sample firms. As I did not have access to additional innovation or research and development data in the form of surveys, questionnaires, or other qualitative sources, I have chosen to estimate annual R&D intensities purely based on the accounting figures. This is a method used in various prior research, albeit the exact variables vary from somewhat among the studies. The two methods that seemed to appear most frequently were R&D in relation to sales (see, e.g. Lome, Heggeseth, & Moen, 2016) and R&D to total assets (see, e.g. Flammer & Ioannou, 2018); therefore, these two intensities were chosen to be included in this thesis.

In order to answer the research hypotheses chosen for this thesis, I will conduct three different regression models that will be presented in subchapter 4.5. Thus, I will generate three different variations of the focus variable for the regression models.

Pre-recessionary year

The first measures of R&D intensity are to be included in the first regression model, attempting to answer the first hypothesis. Pre-recessionary R&D spending in relation to total sales respectively total assets will be the first point of examination, as I study whether differences in R&D intensity affect how firms experience the recessionary years of 2008 and 2009.

$$R\&D_{1,2007} = \frac{R\&D\ Expenses_{2007} + Capitalized\ R\&D\ Expenses_{2007}}{Total\ Sales_{2007}}$$

$$R\&D_{2,2007} = \frac{R\&D\ Expenses_{2007} + Capitalized\ R\&D\ Expenses_{2007}}{Total\ Assets_{2007}}$$

Some of the previous studies have found an approximately two-year lag and few even a one-year lag (Del Monte & Papagni, 2003), which is certainly of interest regarding this hypothesis and the approximation to the beginning of the recessionary period.

Recessionary years 2008-2009

The second measures of R&D intensity are based on the same formula as the previous one, although this time for the two recessionary years that are of specific interest in this thesis. These four proxies for R&D activities during the recession will be applied to the second regression model, in an attempt to answer the second hypothesis, whether recessionary R&D spending can explain later differences in firm performance.

$$R\&D_{1,2008} = \frac{R\&D\ Expenses_{2008} + Capitalized\ R\&D\ Expenses_{2008}}{Total\ Sales_{2008}}$$

$$R\&D_{2,2008} = \frac{R\&D\ Expenses_{2008} + Capitalized\ R\&D\ Expenses_{2008}}{Total\ Assets_{2008}}$$

$$R\&D_{1,2009} = \frac{R\&D\ Expenses_{2009} + Capitalized\ R\&D\ Expenses_{2009}}{Total\ Sales_{2009}}$$

$$R\&D_{2,2009} = \frac{R\&D\ Expenses_{2009} + Capitalized\ R\&D\ Expenses_{2009}}{Total\ Assets_{2009}}$$

The fit of the two R&D intensity indicators will be under scrutiny, as the expected demand shock caused by the recession might skew the R&D to total sales ratio. This would

provide a misleading picture of the actual R&D intensity the firms normally possess. Therefore, R&D to total assets might suffer less variation, depicting a more accurate and comparative view of the R&D activities of the firms for these two years.

Increased R&D activity during recessionary years

The final variation of measurement for firms' R&D activities will be a combination of the two previous ones but assuming the form of a dummy variable instead. It is derived from comparing R&D spending during 2008 respective 2009 to the base year of 2007, as the last pre-recessionary year in the study. Those firms that increase their R&D spending in relation to total assets both 2008 and 2009 assume the role of 1, while those that do not, assume the role of zero.

$$R\&D/TA\ Dummy_{08-09} = \left[1_{R\&D_{2,2008-2009} > R\&D_{2,2007}}\ or\ 0_{R\&D_{2,2008-2009} < R\&D_{2,2007}}\right]$$

This dummy variable will be used in the third regression model, in an effort to answer the third hypothesis: whether increasing R&D spending during recessionary years could improve later firm performance, compared to those that do not increase their spending. Research and development spending in relation to total assets was chosen as the variable to be compared, as R&D to total sales is expected to increase as the expected demand shock of the recession decreases firm revenues.

In addition to the regression analysis, the dummy variable will be analysed with the Mann-Whitney-Wilcoxon test to examine how the firms that increased their R&D activities during the recessionary time period differ in later firm performance from those firms that decreased their R&D activities. This method will be described in more detail in subchapter 4.5.3.

4.4.3 Control variables

Now that I have presented the variables that are my main focus in this thesis, I will follow with the control variables that are used in the study. Firm performance is not a result of a single action or resource, but rather something that is determined by a multitude of variables. In order to account for some of these firm characteristics that are known to affect firm performance based on prior research, I will include these as control variables in the regression models. As the main focus is on R&D activities' effect on firm

performance, by including these control variables, I will be able to reduce the unexplained variation that may otherwise affect the shown effect of R&D has on firm performance.

These control variables have been chosen based on prior, corresponding analysis on R&D or firm performance and periods of recession (see, e.g. Knudsen, 2019; Nason & Patel, 2016; Ratvik & Svergja, 2016; Tubbs, 2007).

Firm size

Firm size is usually linked to firm performance, as economies of scale offer larger firms efficiency benefits that the smaller firms cannot enjoy to the same degree. Porter (1980) interprets these size effects also as plausible entry-barriers to markets. Firm size may also positively affect the possibilities of dividing research and development costs on bigger revenues, whereas the R&D intensity is normally higher for smaller companies (Tubbs, 2007). There are also aspects in firm size that may affect firm performance negatively during recessions, as drastic changes in firm strategy during times of economic shocks would lead to high costs for the larger firms (Knudsen, 2019). Higher levels of financial reserves and superior access to external financing also allow larger firms to wait out possible demand shocks, while younger firms need to adjust their business based on the impact.

$$Firm\ Size\ (Total\ Assets) = \ln\ (Total\ Assets)_{t1}$$

As an alternative to this measure, the natural logarithm of the total sales was tested, although it was found to be inferior regarding the impact on the explanatory power. In prior research, alternative measures on firm size have been the natural logarithm of annual average personnel and market capitalisation.

Liquidity

As earlier concluded, the internal financing capabilities of a firm are essential for investments in R&D (Czarnitzki & Hottenrott, 2011). Low levels of liquidity might result in firms not being able to invest in NPV positive project opportunities and there are also clear indications that liquidity also affects product market outcomes and financial performance positively (Myers & Majluf, 1984; Wang, 2002). Also, as mentioned regarding the firm size, having access to financial reserves might alleviate the distress the firm experiences during recessions.

$$Cash\ Ratio\ = \frac{Total\ Cash\ Holdings}{Total\ Assets}$$

Based on this hypothesis above, the cash ratio is expected to show its highest effect on firm performance during the recessionary time period of 2008 and 2009.

Leverage

In order to control for performance effects deriving from the capital structure of the firm, I will include the debt ratio as a control variable. Under what was assumed *normal* market conditions, the capital structure was originally seen not to affect firm value, according to Modigliani and Miller (1958). Implicitly, seeing that firm value is not affected by the capital structure, this would indirectly implicate that firm performance is neither affected by the capital structure of choice. However, later studies have shown that the capital structure of the firm may affect its performance.

Myers and Majluf (1984) find that chosen financing methods of firm investments act as an information signal to stakeholders, resulting in the pecking order theory. Debt overhang might lead to situations where the firm is not able to invest in NPV positive projects, leading into underinvestment and therefore, decreased firm performance. The negative effect of leverage on firm performance has been found in diverse papers (Bhagat & Bolton, 2008; King & Santor, 2008), while other studies have found a positive effect (Margaritis & Psillaki, 2010; Weill, 2008). Nevertheless, whether the effect leverage has on firm performance is positive or negative, these results indicate the need for this control variable:

$$Debt\ Ratio\ = \frac{Total\ Liabilities}{Total\ Assets}$$

Furthermore, Opler and Titman (1984) report that highly leveraged, R&D active firms suffer the most during periods of economic distress, which further validates the need for this control variable in this study. Due to these findings, it is presumed that the debt ratio will have its greatest significance during the recessionary years of 2008 and 2009.

Fixed assets ratio

While the need for fixed assets greatly varies in different industries, they may also be seen as a signal of a firm's financial stability. Fixed assets are long-term in nature, bought

for usage in firm operations and thus, the organic conversion to cash of these assets might take over one year (Kieso, Weygandt, & Warfield, 2013). Firms that have a high ratio of fixed assets in relation to total assets may have several advantages over those that do not. For example, these assets may act as collateral for firms when applying for external financing, as opposed to the more arbitrary and firm-specific nature of R&D as an asset. This could result in lower debt costs for the firm with higher proportions of fixed assets, as well as access to debt that would not otherwise be available to the firm (as a result of increased security through collaterals) (Welch, 2013). Therefore, I will control for this variable by dividing fixed assets with the total assets of the firm:

$$Fixed\ Assets\ Ratio\ = \frac{Fixed\ Assets}{Total\ Assets}$$

Here fixed assets are defined as the tangible, long-term assets of the company; that is, property, plant, and equipment (PP&E). Due to the aforementioned relationship to debt, I expect to see a significant correlation with the debt and liquidity level of the firm.

Firm age

Another control variable to be included in the regression models is the firm age, as this may affect firm performance by proxy, but not directly. The accumulation of reputation throughout the time period the firm has been active, through well-established routines and certain organisational perseverance developed over the years might give an edge to older, established firms (Coad, Holm, Krafft, & Quatraro, 2018). During times of recession, these firms may also be perceived by investors as stronger and of higher quality, than their younger counterparts and thereby, be affected by the "flight to quality"-phenomenon (Bernanke, 1983). This "liability of newcomers" may also lead younger companies to lose suppliers and customers, as they may not hold as established and loyal customer bases as the older firms (Knudsen, 2019).

$$Firm\ Age\ = \ln(Age)_{2018}$$

Firm age has been based on the year of establishment, which has been noted in the financial statements of each sample firm. In his paper, Knudsen (2019) measures firm age as the natural logarithm of the first year of his study, but as an increase in firm age is constant for all firms, the chosen year does not play a pivotal role. I have chosen the last

year of my analysis, 2018, as the year measuring firm age and take the natural logarithm of that value for all sample firms.

Industry dummy

As the sample firms are active in different business sectors, I will adopt an industry dummy in the analysis. This sample differentiation between different industries is vital, as the R&D activities and intensities greatly vary, depending on the general industry characteristics mentioned in chapter 2.2.1. This dummy variable will capture industry-level effects that otherwise might affect the estimation accuracy of R&D activities' effect on firm performance (Coad & Rao-Nicholson, 2010). It also accounts for any possible industry-specific omitted variable bias that could intervene in the regression models and therefore, significantly affect the results. Two-digit ICB-codes are applied when measuring industry.

$$Industry\ Dummy_j = \left[1_{Industry=j}\ or\ 0_{Industry \neq j}\right]$$

Country dummy

Furthermore, as this dataset includes listed firms both from the Oslo and Helsinki Stock Exchange, I will adopt a country-specific dummy. As seen in Figure 4.1, the two countries have experienced both the recessionary period, as well as the subsequent time period differently. Especially, when comparing the years 2012 to 2014, Finland was in recession while Norway was not, which might translate into worse firm performance for the Finnish firms in the sample. Therefore, the country dummy will be included in the regression models to ensure further validity in the study.

$$Country\ Dummy_j = \left[1_{Country=j}\ or\ 0_{Country \neq j}\right]$$

4.5 Empirical methodology

In this subchapter I will present the statistical analysis method I will use in order to analyse the effect R&D activities may have on future firm performance. I will elaborate on the theoretical background on both ordinary least squares (OLS) regressions as well as multiple linear regressions. The theoretical backdrop in this subchapter will be based on Wooldridge (2015) unless otherwise stated.

4.5.1 Regression analysis

In its simplest form, a regression analysis examines how variable Y is affected by changes in variable x. Here, the variable Y is also referred to as the response or dependent variable, whereas x is referred to as the independent or explanatory variable. An Ordinary Least Squares (OLS) regression analysis draws a linear line through the observations, determined by minimising the sum of squared distances between the regression line (Wooldridge, 2015). The algebraic equation takes the form of:

$$\hat{Y} = \beta_0 + \beta_1 x_1 + \varepsilon$$

The simple OLS regression model has $\hat{Y}$ as the predicted value of Y given by the model, β_0 as the constant in the regression, β_1 as the variable beta that measures the effect x_1 has on Y, and lastly, ε as the error term. The error term catches the effect of the changes in Y that the model is unable to explain based on the chosen independent variable(s).

In practice, a simple OLS regression is often lacklustre when trying to explain complex statistical questions. It is often a combination of different factors that explain the variation in the dependent variable, which is thus unexplainable with merely one independent variable. Therefore, multiple regression analysis is generally used as it includes several independent variables of influence. The model for a multiple regression analysis can be shown as follows:

$$\hat{Y} = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \cdots + \beta_n x_n + \varepsilon$$

In order to account for several explanatory variables rather than just one, I will adopt multiple regression analysis in this thesis. This offers the chance to improve the explanation power of the variation in *Y* when compared to a simple OLS regression. It is done with the variables presented in the previous chapter and that are chosen as they are known to affect firm performance, based on prior research. The specifications for the multiple regression models are presented in chapter 4.5.3 below.

4.5.2 Gauss-Markov assumptions for OLS-regression

While a regression analysis does not discriminate the usage of any dataset or how the analysis itself is used, there are still several conditions that affect how valid and accurate the results are. Possible significant bias may exist in the dataset, making the regression

results less feasible to correctly represent the relationships between the variables in an actual population. To account for this, there are several assumptions to ensure that the regression analysis is unbiased. These are known as the Gauss-Markov assumptions or theorem.

Assumption 1: There is linearity in the parameters.

Assumption 2: The dataset is a random sample of the whole population.

Assumption 3: No perfect collinearity exists between the independent variables, and neither are any of them a constant.

Assumption 4: The expected value of the error term is zero, $\varepsilon(u|x) = 0$.

Assumption 5: Error term assumes equal variance for any independent variables (Homoscedasticity), $Var(u|x) = \sigma^2$

To reach unbiased OLS estimates the first four assumptions must hold, signifying that the probability distribution of an explanatory variable is estimated to represent a value true to the whole population, $(E(\beta) = \hat{\beta})$. If the fifth assumption does not hold, it means that the regression model estimates show heteroscedasticity. This does not affect estimator bias, but rather it reduces the estimator's efficiency that is measured in standard errors of the coefficients. This is taken into consideration in the thesis and explained comprehensively in chapter 4.6.2.

4.5.3 Specification of the regression models

I will now introduce the regression models that will be applied in the analysis, in order to either validate or reject the research hypotheses presented in chapter 3.4. This subchapter will not explain in detail the variables used in the models, as those are discussed thoroughly in chapter 4.4.

General model for regression

The following equation presents the base model used in this thesis to study the relationship between firm performance and the R&D activities of a firm:

$$Firm\ Performance_{Y1-4,t1} = \beta_0 + \beta_1 R\&D_{1-2,\ 2007-2009} + \beta_2 Debt\ Ratio_{t1} + \beta_3 Cash\ Ratio_{t1} + \beta_4 Fixed\ Assets\ Ratio_{t1} + \beta_5 Firm\ Size_{t1} + \beta_6 Firm\ Age_{2018} + \beta_7 Industry\ Dummy + \beta_8 Country\ Dummy + \varepsilon$$

Equation 1 General Regression Model

As this equation is quite lengthy, the independent variables β_2 -β_8 will be abbreviated into control variables in the latter regression model variations. The control variables will stay constant in the following variations of the regression model.

R&D activities affecting recessionary firm performance

Linking the regression model into the first research question if firms' R&D spending affects their future firm performance, this equation will use the pre-recessionary R&D intensity as the focus variable affecting firm performance during the recessionary time period of 2008 and 2009.

$$Firm\ Performance_{Y1-4,t1} = \beta_0 + \beta_1 R\&D_{1-2,\ 2007} + [Control\ Variables] + \varepsilon$$

Equation 2 Regression model for Recessionary Performance

Running this regression model will yield results that either validate or disprove the first hypothesis.

Recessionary R&D activities affecting later firm performance

This variation of the base regression model estimates if differences in R&D intensities during the recessionary years 2008 and 2009 affect later firm performance, measured during the years 2010 to 2018.

$$Firm\ Performance_{Y1-4,t1} = \beta_0 + \beta_1 R\&D_{1-2,\ 2008-2009} + [Control\ Variables] + \varepsilon$$

Equation 3 Regression model for Recessionary R&D activity intensity

Much like the first regression model, it is closely related to the second research question, as well as the second hypothesis.

Increased R&D activities during the recessionary years

This regression model is very much linked in the second research question, analysing if those firms that increase their R&D/TA intensity during the recessionary time period perform better or worse at a later time period than their counterparts. The model, therefore, resembles closely the previous model, but instead of just measuring the R&D

intensity as percentual changes, it will adapt a dummy variant of those firms that increase/decrease their R&D spending for the recession period.

$$Firm\ Performance_{Y1-4,t1} = \beta_0 + \beta_1\ R\&D/TA\ Dummy_{\ 2008-2009} + [Control\ Variables] + \varepsilon$$

Equation 4 Regression model for Increased Recessionary R&D Activity

This final variation of the regression will either corroborate or reject the third, and the final hypothesis of this thesis.

4.5.4 Mann-Whitney-Wilcoxon test

In addition to the multivariate regression models, I will also adapt the non-parametric Mann-Whitney-Wilcoxon (MWW) test (also called Mann-Whitney U test) to analyse the two groups of firms that either increased or decreased their R&D activities during the recession. Specifically, the later firm performance of these two firm groups is of interest, and the MWW-test is meant to complement the results from the regression analysis. Is there a difference between those that increased their R&D intensity in 2008 and 2009, when compared to those that acted oppositely? The null hypothesis is that there is no tendency of the ranks (firm performance) in one group to be systematically higher or lower than for those in the other group.

The firms are divided into two groups, based on the R&D dummy variable presented in chapter 4.4.2. The firm performance is then analysed year by year from 2010 to 2018, including all firm performance indicators.

As this non-parametric test compares medians instead of means, it is not sensitive to extreme values and therefore, it does not require a normal distribution for the variables. If the variables were normally distributed, the parametric equivalent test would have been the T-test for independent samples.

The smaller of the two U statistics that are measured in the test is derived from (Corder & Foreman, 2014):

$$U_i = n_1 n_2 + \frac{n_i(n_i+1)}{2} - \sum R_i,$$

where n_i is the number of values from sample examined, n_1 and n_2 are the number of values from respective samples and $\sum R_i$ is the sum of the ranks from the sample of

interest. After analysing for the U statistic, it is then further inspected for significance or alpha (α), at a level of 0.05. With a smaller sample (<20) it would be possible to use a table of critical values to find the value that is to not be exceeded, in order to reject the null hypothesis. The sample analysed in this thesis varies from 82 to 89, so this is not a viable option. Instead, as Corder and Foreman (2014) suggest, a large sample approximation can be carried out by computing a z-score and using a normal distribution table to find critical values of z-scores. As this is done automatically by SPSS, I will not go into greater detail behind the mathematical model, but rather present the results of the test in chapter 5 and discuss those more in-depth in chapter 6.

4.6 Data concerns and validity

Much alike any other dataset, there exist concerns regarding analysing this data, which may affect both the validity and reliability of this study. First the statistical concerns of the data will be discussed, presenting how multicollinearity and heteroscedasticity will be taken into consideration. Following this, the validity and reliability of the study will be discussed in detail.

4.6.1 Multicollinearity

Multicollinearity is defined as a high, albeit not a perfect correlation between two or more independent variables (Wooldridge, 2015). Instead of actually breaching any of the Gauss-Markov assumptions for unbiasedness of regressions, multicollinearity is problematic as identifying which of the collinear independent variables are of interest, becomes futile. Nevertheless, all regression models show a correlation to some degree between the independent variables (Hair, Black, Babin, & Anderson, 2019).

In order to inspect the several regression models for multicollinearity, there are a few alternatives to consider. One of the simplest procedures to do this is through examining a correlation matrix, in this case a Pearson's r matrix. Shown in Table 5.4 and Appendix 6., the correlation between the independent variables can be seen for all the annual variables used in the regression models. The two coefficients that show the highest levels of correlation, of those that are actually used in the regressions, are the two measures of R&D intensity and cash holding ratio. The highest correlation between cash ratio and R&D intensity is 0.779 throughout this 11-year period. This is a quite high level of

correlation, albeit not exceeding the 0.8 threshold, but nevertheless worth investigating further.

The *variance inflation factor* test (VIF) is a method to analyse how much the multicollinearity inflates the variance of the coefficient estimate. The general assumption is to investigate variables with a VIF exceeding 4 and those that exceed a threshold of 10 show serious multicollinearity issues (Hair, Black, Babin, & Anderson, 2019). As mentioned by Hair et al. (2019) this VIF threshold of 10 is corresponding to a tolerance value of 0.10, thus also suggested as a cut-off value for values of tolerance. Running VIF-tests in unison with the several regression models show no independent variables with VIF values above 4, other than for the industry and country dummies. These high VIFs for the dummy variables are although expected and do not cause issues with the regression estimates. The VIF values are shown in Table 5.6 and Appendix 7.

4.6.2 Heteroscedasticity

As previously mentioned, in order to ensure that the regression is unbiased it must fulfil certain assumptions, also known as the Gauss-Markov assumptions. One of these assumptions is the homoscedasticity of the independent variables, as in assumed equal variance for the error term. If heteroscedasticity would be present in the regression model, rather than affecting the biasedness of the estimates, it would instead reduce the model's efficiency. To check for heteroscedasticity in the regression models, I will apply the Breusch-Pagan test for heteroscedasticity.

The Breusch-Pagan (BP) test is used to detect heteroscedasticity in linear regression models, assuming that heteroscedasticity is a linear function of x_j (Breusch & Pagan, 1979). The test regresses the squared residuals of the independent variables with a null-hypothesis of homoscedasticity, given that the p-value is above a critical level (Wooldridge, 2015).

$$\hat{u}^2 = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + \cdots + \delta_k x_k + \epsilon$$

The example model above assumes merely two independent variables, instead of the eighteen independent variables used in the actual regression models. If the regression models would include interaction or non-linear terms, the BP test would not be sufficient and require an alternative test to supplement. White test for heteroscedasticity could be a

viable option for this. Although, as the regression models used in this thesis lack interaction terms or non-linear variables, the Breusch-Pagan test is ample to check for heteroscedasticity. In a majority of the regressions performed, the test provided a p-value of 0.000, indicating heteroscedastic errors for linear relationships in the model.

In order to adjust the regression results for heteroscedasticity, I will apply heteroscedasticity-consistent standard errors as recommended by Wooldridge (2015). Using these robust standard errors result in increased standard errors that are causing the reduced model efficiency. If the sample size is small, these robust standard errors may affect the estimated coefficients (Wooldridge, 2015). As the sample size is equal or below 250, I will employ the supported HC3 in accordance with Long and Ervin (2000).

4.6.3 Validity

In research it is of importance to evaluate the quality of the study and whether its results stand when subjected to scrutiny. To discuss this in detail, this section will discuss the validity of this study from different aspects: construct validity, internal validity, and external validity.

Construct validity

Construct validity refers to whether correct operational measures are established for the concepts that are to be studied. In this study, it is relevant regarding the different measures for firm performance as well as for measuring the research and development activities of the firm.

In order to acquire an overview of firm performance, I have included several performance variables to measure firm performance from different aspects. First, the operating efficiency of the firm will be measured through the EBITDA margin and ROA. Second, successful product innovation should result in increased sales, thus measuring sales growth is of relevance. Third, as the sample comprises of public firms, the market valuation of these companies is an additional aspect to analyse, leading to using Tobin's q as the final firm performance variable. These variables are commonly used in research combining firm performance and the innovative activities of the firm, although isolating the effect is not a simple feat (Tubbs, 2007). To gain a more accurate view of this innovation-performance relationship, several analyses include adjustments for both

industry- and country-specific effects as well as control variables. Much alike any empirical study regarding firm performance, there is still the concern of isolating the specific effect from the focus variable.

Measuring the research and development activities of the firm is done through a proxy, as in intensity in relation to either total assets or revenue. While this proxy has been used in prior studies in different variations, it can be accepted to offer limited insight into the actual process of innovation within firms. The variable does not differ between the different types of activities done within R&D, but rather cluster all processes into one unit of expense for the firm. Certainly, including the activated R&D costs into this proxy measure give some indication of the R&D process that has been done with this spending, as the criteria for capitalisation are strict. These capitalised expenses indicate that the output of the R&D process could provide the firm future cash flow, while the general spending on R&D expensed through the income statement does not fulfil to offer such outlook. Therefore, while this proxy measure of R&D depicts the activity as mere costs for the company, there is still support for using this aggregate measure from prior studies. While it may not offer the same depth of insight as qualitative innovation data could offer regarding the innovative activities of the firm, I am still confident this proxy measure could offer some increased understanding of how the R&D spending affects firm performance throughout the business cycle.

Internal validity

Internal validity concerns questions regarding whether two or more variables truly have a causal relationship (Bryman & Bell, 2011). This is imperative in quantitative research to be able to differentiate whether the relationship between the variables is purely correlated or if causality exists. The secondary data in this thesis is based on financial figures, with time-lags included in the regression models. In order to further ensure the internal validity of the study, the research design is based on the available theory as well as prior research (Bryman & Bell, 2011).

Including all relevant independent variables in the regression models is also of concern, as omitting variables that should have been included in the model will have implications on the validity of the study. In order to account for this, I have thoroughly investigated available literature to identify well-known variables that may affect firm performance and

thus, included those in the study as control variables. There are still limitations regarding this, as the data used in the study is solely quantitative to its nature, whereas the inclusion of qualitative data could have included a more multifaceted point of view on the study.

In studies regarding innovation and firm performance, one issue that arises is simultaneity. Do (low-) high-performing firms innovate more, or do innovative firms simply perform better (worse)? While the time-lagged regression model provides some hints regarding the direction of this relationship, there are still uncertainties that need to be accounted for and these will be discussed further in chapter 6. To further increase the validity of the study, I use Pearson's r correlation matrix to ensure the absence of multicollinearity in the independent variables that are used in the regression models.

External validity

External validity concerns the question of whether the findings of the study can be generalised outside the chosen research context (Bryman & Bell, 2011, p. 43). As previously mentioned in the theory chapter, recessions vary by their length, severity, and causation, which makes the generalisation of these findings debatable. Nevertheless, recessions still share credit constrains and demand chocks as common effects, according to Knudsen and Lien (2014), making these findings generalisable to other recessionary periods.

Still, within external validity there is also the concern of time validity, which is obviously an issue that is difficult to account for, as the data is based on historical accounting figures and share prices. Past performance is not indicative of future results, making time validity a concern that cannot be accounted for, due to the nature of the study.

Reflecting back on Figure 4.2, the research and development activities of Norway and Finland differ during this time period to some extent. While R&D in Finland was nearly twofold of that in Norway, the gap between the countries has decreased considerably over time and currently approximately represents the OECD average as well. Therefore, there is support for the findings to be generalised to at least other developed OECD countries.

5 ANALYSIS

Having presented the data, the variables used in the study, and the regression models, this chapter will now present the analysis results. First, R&D activities of the sample firms on a country- and industry-level basis will be presented, along with firm performance indicators for the total sample, as well as separate for both countries. Then, the regression results are shown, first presenting the control model for each regression, and then including the R&D focus variable in each model. Lastly, the findings are summarized before the discussion chapter.

5.1 Development in R&D and firm performance

In order to depict a picture of the general development of R&D spending and firm performance during the time period of interest in this study, this section will provide a country- and an industry-specific overview of these aspects.

5.1.1 R&D activities in the sample

To begin the analysis, I will present a simple illustration of the R&D activities for the total sample used in this thesis. The table below presents the R&D spending in relation to revenues and total assets as annual averages in percentages.

	R&D Intensity as Percent of								
	Total Sample			Norwegian Firms			Finnish Firms		
Year	Number of Firms	Total Sales	Total Assets	Number of Firms	Total Sales	Total Assets	Number of Firms	Total Sales	Total Assets
2007	87	8.20	5.95	24	16.62	10.40	63	4.29	4.40
2008	88	13.27	6.79	24	33.35	13.68	64	4.50	4.61
2009	88	7.41	7.32	24	14.07	14.48	64	4.43	4.33
2010	89	9.75	5.74	25	21.34	10.91	64	3.96	4.22
2011	88	11.15	6.47	24	26.02	11.48	64	7.23	4.46
2012	89	7.54	7.15	25	17.78	15.25	64	4.59	4.34
2013	87	6.94	6.41	23	10.85	10.96	64	4.57	4.50
2014	89	6.73	5.44	25	12.97	5.90	64	4.72	4.36
2015	89	5.69	5.93	25	9.98	8.86	64	4.22	3.84
2016	89	6.04	5.04	25	8.12	5.63	64	4.63	4.06
2017	88	5.81	6.50	25	10.84	9.34	63	4.63	4.32
2018	82	6.76	6.46	25	6.35	5.94	57	5.78	5.31
Average	88	7.94	6.27	24	15.69	10.24	63	4.80	4.40

Table 5.1 R&D intensities (%), sample average 2007-2018

In Table 5.1, the annual R&D spending in relation to sales and total assets is depicted, differing between the Finnish and Norwegian firms and the total sample. It is noteworthy

that the R&D intensity is much higher among the Norwegian companies with high yearly variance. Comparing these to the Finnish sample, the figures are quite stable and showing low variance throughout the time period.

Looking at the total sample, the major changes in the R&D intensity appear to happen during 2008 and 2010-2011. For the Norwegian companies these large variations are likely to be caused for two reasons. Firstly, the firm sample is less than half of those included in the Finnish sample, and therefore, large annual deviations in a few companies result in a more noticeable effect on the whole country-specific firm sample. Secondly, as the R&D intensities are from 2007 to 2013 more than double their Finnish counterparts, it can be assumed that the Norwegian sample consists of young, R&D-intensive companies with low sales figures and small balance sheet values in relation to their R&D spending. The low revenue assumption could explain the sudden doubling of R&D to total sales between 2007 and 2008, as the financial crisis hit in 2008, leading to demand reductions for many firms.

As the focus of this thesis is on the pre-recessionary and recessionary R&D activities of the sample, the next table presents the R&D spending on an industry-level for these years of interest. The industries are ranked by R&D expenditures relative to annual sales.

R&D Intensity as Percentages, Annual Averages						
ICB/ Year	R&D/Sales			R&D/TA		
	2007	2008	2009	2007	2008	2009
4500	41.53	74.54	16.46	15.76	21.15	31.03
9500	18.66	26.44	14.06	15.06	16.22	15.64
3500	5.71	7.61	14.44	4.25	9.17	8.54
3300	3.16	3.03	1.51	1.76	2.91	3.54
2700	2.50	2.49	3.01	5.53	5.18	3.91
500	2.48	2.07	0.94	1.13	1.23	1.03
2300	1.96	2.54	3.09	2.49	3.02	3.29
3700	1.30	1.29	1.72	1.94	1.94	1.93
1300	1.27	2.51	0.96	1.28	1.39	0.80
6500	0.51	0.80	0.34	0.31	0.52	0.44
1700	0.49	0.52	0.46	0.45	0.48	0.53
5500	0.43	0.31	0.58	0.72	0.51	0.20
Average	6.67	10.35	4.80	4.22	5.31	5.91

Table 5.2 R&D intensities (%), industry averages 2007-2009

As shown in Table 5.2 above, the R&D spending in relation to sales and total assets varies considerably among the different industries. Unsurprisingly, the two industries that display the highest R&D intensities are Health Care respective Technology. The drugs

and pharmaceutical companies that spend remarkable amounts on developing new medicine are included in the Health Care industry, which explains the high R&D intensities. Of the 6 companies included in the sample, many were relatively young with low revenues, thus resulting in very high R&D to sales ratios for the years 2007 and 2008.

Examining the lower end of the table, the industries Media, Basic Resources, and Telecommunications rank as the bottom three industries in R&D intensity. Among these industries, the sample firms boast solid revenue streams and total assets that also reflects in the relatively stable research and development intensities during these three years. Also, while the R&D spending still might translate into millions of NOK or EUR, in relation to the revenues or total assets, the amounts are still lower than in the other industries included in the study.

This table further confirms the need to differentiate between industries in the regression models, as the industry-specific effects would interfere with the results considerably. Also, noteworthy is that both in Table 5.1 and 5.2 the R&D intensity measured in relation to total sales fluctuates more than R&D to total assets. This demand shock that decreases the sales during the recession would skew the R&D intensity to an abnormally high level, which would affect the analysis results. Therefore, in order to ensure that a more realistic R&D intensity of the firms during this time period is depicted, R&D to total assets will be used in the regression analysis.

5.1.2 Performance indicators in the sample

Next, in order to assess how the recession and the subsequent time period have affected firm performance, I have compiled the annual averages for the performance indicators of the sample in Table 5.3 below and for Tobin's q in Figure 5.1.

Performance Indicators as Percentages, Annual Average									
	Total Sample			Norwegian Firms			Finnish Firms		
Year	ROA	Sales Growth	EBITDA Margin	ROA	Sales Growth	EBITDA Margin	ROA	Sales Growth	EBITDA Margin
2007	7.49	N/A	12.11	4.41	N/A	7.50	8.59	N/A	13.62
2008	2.85	3.83	11.29	-6.06	3.78	11.32	6.19	3.85	11.28
2009	0.82	-16.43	8.92	-3.75	-15.10	8.78	2.47	-16.93	8.96
2010	2.03	10.24	11.19	-4.20	10.93	11.71	4.37	9.97	11.03
2011	1.59	1.83	9.34	-3.04	-0.25	9.49	3.33	2.60	9.29
2012	0.73	4.73	10.60	-6.11	8.21	11.85	3.19	3.32	10.20
2013	-0.06	-4.57	7.82	-6.94	4.35	2.54	2.52	-8.19	9.69
2014	1.94	2.34	9.03	-3.24	6.69	10.71	3.96	-0.85	9.91
2015	0.29	7.03	9.02	-8.94	18.80	7.82	4.10	2.43	9.47
2016	3.94	-0.75	9.01	0.76	-2.56	10.15	5.20	-0.04	8.59
2017	1.06	6.80	13.00	-7.43	15.98	12.99	4.62	3.01	13.00
2018	3.29	3.76	12.03	-2.99	4.10	14.20	5.78	3.62	11.20
Average	2.16	1.71	10.28	-3.96	4.99	9.92	4.53	0.25	10.52

Table 5.3 Performance indicators (%), annual averages 2007-2018

Evaluating the dependent variables on an annual and country-specific basis, there are some interesting findings. First, while ROA is at its lowest point for the whole sample during the year 2013, it experienced its peak level of 7.49% in 2007. Both countries firm samples experienced their climax during that year, after which the Norwegian companies have averaged a negative Return on Assets, with the only positive exception being in 2016. The Finnish companies exhibit a positive ROA throughout the whole time period, even though the country itself has experienced a recession at least twice during this study period, based on the GDP evolution presented earlier in Figure 4.1. One probable reason for this difference between the two countries is the small sample of Norwegian firms, of which many were also young, while the Finnish companies are not only many more but also older with proven track records of profitability.

Second, reflecting back on the same Figure 4.1 depicting the GDP development of the two countries, it was expected that the Finnish firms would generally exhibit worse performance in 2008 and from 2012 to 2014. In 2008 the firms of the two countries fared relatively similarly, with the only difference being the priorly mentioned superior ROA performance of the Finnish firms. From 2012 to 2014, however, while the Finnish firms'

ROA stayed superior to their Norwegian counterparts, the Norwegian firms show higher sales growth as well as slightly outperform the Finnish firms in the EBITDA margin for two of these years.

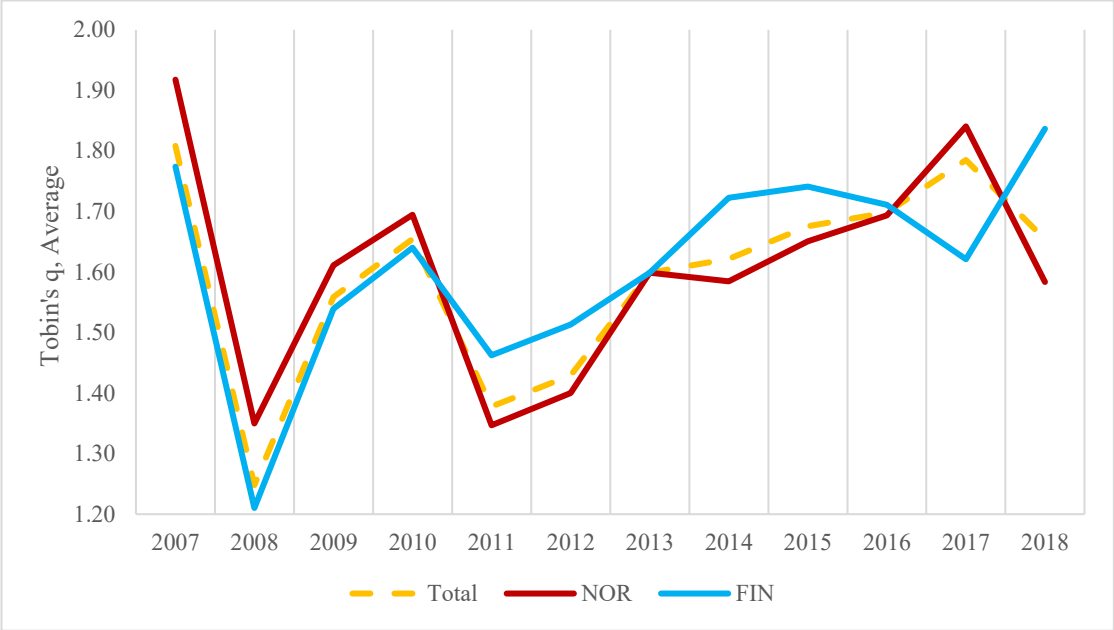

Figure 5.1 Tobin's q, annual averages 2007-2018

Examining how Tobin's q evolved during this time period of 11 years, there are immediately some noteworthy findings. First, during this entire time period the sample average of Tobin's q has stayed fairly high, averaging between 1.2 to 1.8. This would indicate that the sample firms are overvalued, or rather, have high growth expectations that the market has valued in the valuation of these firms. Likewise, it might also be an indication of the investors recognising some additional value-building assets or capabilities that these firms possess, with these being of such nature that prevents them from being displayed on the balance sheet of the firm; therefore, leading into Tobin's q values above one.

Second, it is immediately noticeable how gravely the financial crisis of 2008 impacted the market valuation of these companies, as the average Tobin's q sank from 1.8 the year prior to 1.2 by the year-end of 2008. Surprisingly, although the lagged impact of the recession severely affected the operations of these firms in 2009, as shown in Table 5.3, Tobin's q still rebound back to an average of above 1.5 the same year. This is still somewhat understandable, as the variable is of a forward-looking nature, anticipating future growth expectations contrary to the other performance indicators that merely reflect on past performance. It could, therefore, describe the positive market outlook for

the future that was shared by investors amidst the recession. This positive outlook however, changed into a high level of uncertainty in 2011 amidst the European sovereign debt crisis, with fears of further contagion of countries being unable to repay their debts. Following this, the average Tobin's q grew from 2012 to peak in 2017, followed by a drop in 2018.

Third, and lastly, the general evolution of Tobin's q has been rather identical between the Finnish sample and the Norwegian firm sample. The Finnish sample firms were harder hit in 2008 than their Norwegian counterparts, but then again, they were better off in the shock of 2011 than the Norwegian firms. The average change in Tobin's q in 2017 and 2018 was, although, opposite for the firms in the two countries. These results, however, do not by any means represent the entire picture of how the firms in these countries have developed during this time period in valuation, as the firm samples for both countries are admittedly small; thus, overrepresenting certain industries while omitting others.

While these results do not depict the whole picture of how all of the listed firms in these two countries differ in firm performance during this 11-year period, the results do indeed confirm the need of using a country dummy variable to decrease country-specific effects that might inference the findings in the regression analyses.

5.2 Descriptive statistics

Having presented some general country- and industry-specific trends of firm performance and R&D spending, this section will discuss the basic features of the data used in the analyses. Data distribution and normality will be presented, which will be followed by discussing correlations between the variables that are used in the regression models. Lastly, as this thesis includes 124 separate regressions, it results in a large amount of descriptive statistics tables that need to be included. Therefore, in order to present all this in a tidy manner, I will include most of the tables in the Appendices 5. – 7., while presenting one of each table in this section. I will, however, present any anomalies or other noteworthy findings from these tables that are included in the Appendices, in this section as well.

5.2.1 Descriptive statistics and data normality

In order to acquire an overview of the data used in the analyses, descriptive statistics and data normality tests are provided for the key variables in 2007 and 2008 in the table below, whereas the same information for the remaining years is shown in Appendix 5.

							Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Firm Age	89	3.829	0.792	2.485	5.911	0.345	-0.943	0.955	0.009
Cash Ratio 2008	90	0.142	0.197	0.008	0.919	2.214	4.321	0.633	0.000
FA Ratio 2008	90	0.233	0.177	0.002	0.643	0.465	-0.924	0.936	0.001
Firm Size 2008	90	5.820	2.298	-0.187	11.123	0.017	-0.276	0.969	0.054
Debt Ratio 2008	89	0.542	0.194	0.097	1.356	0.468	2.539	0.981	0.318
ROA 2008	88	0.028	0.151	-0.886	0.241	-3.272	15.746	0.912	0.000
EBITDA margin 2008	84	0.113	0.143	-0.552	0.623	-0.641	6.890	0.834	0.000
Sales Growth 2008	87	0.038	0.264	-0.999	1.242	0.552	8.322	0.784	0.000
Tobin's q 2008	85	1.248	0.597	0.599	3.927	2.385	7.022	0.775	0.000
RD/TA 2007	88	0.061	0.111	0.000	0.622	3.311	12.597	0.619	0.000
RD/S 2007	86	0.076	0.187	0.000	1.132	4.384	20.666	0.362	0.000

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage), and RD/S is research and development spending to total sales (as percentage).

Table 5.4 Descriptive statistics & Shapiro-Wilk test, table 1/11 - 2008

In addition to the mean values, standard deviations, and the minimum and maximum values of each chosen variable, the table shows both the skewness and kurtosis. These are critical values to explore, as they describe whether the dataset is normally distributed, which is an important assumption of an OLS-regression (Wooldridge, 2015). Skewness describes the symmetry of the data, where a value close to zero implicate symmetric distribution, whereas a positive or negative value demonstrate the concentration of the distribution mass on either right respective left tail (Hair, Black, Babin, & Anderson, 2019).

Among the key variables during the whole period of the study, there are certain ones that consistently show a positive skewness. In addition to the R&D intensity measures of 2007, 2008, and 2009, Cash Ratio and Tobin's q exhibit a positive skewness throughout the years, with values ranging from 2.2-3.0 respective 1.3-2.4. Respectively there is one ratio that demonstrates consistently a negative skewness through this same period, with the only exception being 2016, showing a positive skewness. ROA shows mostly a left tail with values varying from -1.0 to -3.3, with the exception of a positive skewness of

1.9 in 2016. Excluding the cash ratio, R&D intensities, and the performance indicators, the highest skewness values are demonstrated by the FA ratio peaking at 0.8 in 2010. Firm size, as a natural logarithm of the total assets, shows skewness values close to zero as anticipated for the transformed data.

The other measure that describes the shape of a distribution of data, is kurtosis. This term refers to the peakedness of a probability distribution, where distributions taller than the normal distribution are called leptokurtic, while those that are flatter, are referred to as platykurtic (Hair, Black, Babin, & Anderson, 2019, p. 43). As the kurtosis of a normal distribution is approximately three, those that exceed that value exhibit a leptokurtic distribution, whereas those with a value below three demonstrate a platykurtic distribution. The statistical program SPSS automatically subtracts this pivotal value of three, resulting in any negative values indicating a platykurtic distribution respectively positive values a leptokurtic distribution. Out of all the variables, there are several that consistently show a leptokurtic distribution; namely, the cash ratio, EBITDA margin, ROA, Tobin's q, and the R&D intensities in 2007, 2008, and 2009. Similarly, there are two variables, FA ratio, and firm size, that exhibit a platykurtic distribution every year, albeit only to the extent of never exceeding a value of minus one.

Furthermore, the tables in Appendix 5 together with Table 5.4 report the results of the Shapiro-Wilk tests. This test that was created by Shapiro and Wilk (1965) measures the normality of a small data sample, having a null hypothesis of a normal distribution. In 2008, and from 2010 onward, the null hypothesis of a normal distribution in the variables can be rejected for all variables except for the firm size and debt ratio. In 2009, however, in addition to the firm size and debt ratio, ROA and the sales growth also exhibit such values so that the null hypothesis cannot be rejected. In summary, most of the variables used in the study do not exhibit a normal distribution during these 11 years.

5.2.2 Tests of correlation

Measuring correlation, as in how a variable reacts to the change of another variable, is done with the Pearson's r correlation matrix. Granted, even though two variables indicate correlation it is not sufficient to confirm the existence of causality regarding the direction of the relationship between these variables (Hair, Black, Babin, & Anderson, 2019, p. 616).

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2008	-.271*	1.000									
	(0.010)										
(3) FA Ratio 2008	0.167	-.467*	1.000								
	(0.117)	(0.000)									
(4) Firm Size 2008	0.299*	-.535*	0.472*	1.000							
	(0.004)	(0.000)	(0.000)								
(5) Debt Ratio 2008	0.065	-.411*	0.248*	0.214*	1.000						
	(0.549)	(0.000)	(0.019)	(0.044)							
(6) ROA 2008	0.124	-.543*	0.139	0.273*	0.352*	1.000					
	(0.254)	(0.000)	(0.197)	(0.010)	(0.001)						
(7) EBITDA margin 2008	0.075	-.339*	0.297*	0.327*	0.188	0.652*	1.000				
	(0.501)	(0.002)	(0.006)	(0.002)	(0.087)	(0.000)					
(8) Sales Growth 2008	-.184	-.033	-.078	0.014	-.040	-.002	0.077	1.000			
	(0.090)	(0.759)	(0.475)	(0.898)	(0.712)	(0.985)	(0.492)				
(9) Tobin's q 2008	0.073	0.362*	-.227*	-.250*	-.197	-.135	0.178	0.012	1.000		
	(0.508)	(0.001)	(0.036)	(0.021)	(0.071)	(0.219)	(0.112)	(0.915)			
(10) RD/TA 2007	-.123	0.717*	-.438*	-.556*	-.280*	-.554*	-.314*	-.276*	0.618*	1.000	
	(0.258)	(0.000)	(0.000)	(0.000)	(0.009)	(0.000)	(0.004)	(0.011)	(0.000)		
(11) RD/S 2007	-.219*	0.748*	-.382*	-.460*	-.312*	-.450*	-.518*	-.214*	0.323*	0.871*	1.000
	(0.044)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.000)	(0.049)	(0.003)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage), and RD/S is research and development spending to total sales (as percentage). Significance levels are presented in parentheses. * Shows significance on a .05 level.

Table 5.5 Pearson's r correlations, table 1/11 - 2008

Table 5.5 above, as well as Appendix 6 report the correlations of the variables used in the several regression models, excluding the dummy variables. The coefficient for each variable adopts a value between -1 and 1, whereas a coefficient of zero indicates no correlation between two variables. If the coefficient between two variables is 1, the change between these two variables is identical, while the opposite is true for a value of -1. As these regression models include several control variables, and thereby, significant correlations between the variables, I will point out the most pivotal ones for this study.

Several correlations corroborate the motives behind the chosen control variables, as their expected relationships with other variables are shown. First, the research and development intensities show high levels of correlation with the liquidity of the firm. Second, liquidity is negatively correlated to firm age, fixed assets ratio, and firm size. This is also quite logical, as older and larger firms usually exhibit higher total assets than their younger and smaller counterparts, this results systematically in a lower proportion of liquidity for these firms. These older and larger firms also often demonstrate higher ratios of fixed assets, as smaller firms may not pertain to those industries that typically have high FA ratios, such as telecommunications, or basic resources sectors. Third, it is noteworthy that whilst R&D intensity to total sales and R&D intensity to total assets show very high levels of correlation that could cause multicollinearity issues, these two variables are never included in the same regression.

Fourth, and most interestingly, these tables present how the R&D intensities correlate with the different firm performance indicators. In the first regression model, shown in Table 5.5 and Appendix 6.1, both measures of R&D intensity demonstrate mostly negative correlations to the profitability measures and sales growth, whilst the correlation is positive to Tobin's q. The exceptions to these results are the insignificant correlations for R&D to total assets in 2007 contra ROA and sales growth in 2009. Surprisingly, R&D to total sales shows a significant and positive correlation to ROA in 2009. Subsequently, the second regression model that is shown in Appendix 6.2 to 6.10, report rather similar correlations between the recessionary R&D intensities and later firm performance. Sales growth in 2012, 2014, and 2016 is shown to have a significant and positive correlation to recessionary R&D intensities, whilst the years in between do not show significant results. Tobin's q demonstrates a positive and significant correlation during this whole post-recessionary period to recessionary R&D intensity, as does the EBITDA margin, albeit with a negative correlation to the R&D intensity. Lastly, ROA exhibits a significant and

negative correlation to the recessionary R&D intensities from 2010 to 2017, with the exceptions of 2010 and 2013 when this correlation was positive for R&D intensity in 2009.

These implications of a negative relationship between the R&D intensities and measures of firm performance, excluding Tobin's q, are quite surprising. However, it is still necessary to further analyse these results before any conclusions can be drawn.

5.2.3 Tests of multicollinearity

As priorly presented in chapter 4.6.1, variance inflation factor (VIF) tests will be carried out to ensure that the regression models would not suffer from multicollinearity issues. While most of these results from the VIF tests can be found in Appendix 7, Table 5.6 below presents the results of one such test measuring firm performance in 2010 with the third regression model.

Dependent:	*ROA 2010*		*Sales Growth 2010*		*EBITDA margin 2010*		*Tobin's q 2010*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.666	1.502	0.652	1.533	0.661	1.513	0.649	1.541
Cash Ratio 2010	0.453	2.208	0.476	2.103	0.648	1.544	0.452	2.213
FA Ratio 2010	0.456	2.195	0.466	2.148	0.413	2.420	0.438	2.283
Firm Size 2010	0.455	2.197	0.435	2.299	0.484	2.066	0.436	2.293
Debt Ratio 2010	0.608	1.645	0.634	1.577	0.677	1.478	0.580	1.723
RD/TA Dummy	0.793	1.262	0.795	1.258	0.811	1.234	0.797	1.255
Country Dummy, FIN	0.693	1.444	0.693	1.443	0.783	1.277	0.707	1.414
Industry Dummy, 0500	0.290	3.452	0.290	3.446	0.304	3.288	0.236	4.245
Industry Dummy, 1300	0.608	1.645	0.608	1.644	0.608	1.644	0.508	1.968
Industry Dummy, 1700	0.314	3.181	0.314	3.181	0.315	3.176	0.225	4.453
Industry Dummy, 2300	0.303	3.297	0.303	3.296	0.301	3.328	0.235	4.256
Industry Dummy, 2700	0.139	7.183	0.144	6.961	0.144	6.933	0.095	10.478
Industry Dummy, 3300	0.585	1.708	0.586	1.706	0.583	1.716	0.474	2.108
Industry Dummy, 3500	0.343	2.919	0.343	2.920	0.343	2.914	0.251	3.983
Industry Dummy, 3700	0.350	2.854	0.350	2.855	0.349	2.863	0.267	3.748
Industry Dummy, 4500	0.272	3.672	0.268	3.726	0.364	2.745	0.200	4.992
Industry Dummy, 5500	0.404	2.473	0.404	2.475	0.401	2.493	0.304	3.289
Industry Dummy, 9500	0.145	6.919	0.137	7.277	0.142	7.063	0.102	9.821

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Table 5.6 Variance Inflation Factor, third regression – 2010

Evident from this table, as well as from the tables in Appendix 7, none of the non-dummy variables indicate any form of multicollinearity issues that would interfere with the regression results analysis. Only the dummy variables exceed the critical tolerance or VIF values in some regressions, although due to the binary nature of these control variables,

they do not hamper the results and may thus be ignored (Hair, Black, Babin, & Anderson, 2019, p. 316).

5.3 Results from analysis

This section presents the results from the various analyses, beginning with how pre-recessionary R&D activities affect firm performance during recessions. It is followed by examining how R&D activities during the recession affect post-recessionary firm performance. Then, how increased R&D activities during the recession affect post-recessionary firm performance will be analysed by two means, as both regression analyses, as well as a Mann-Whitney-Wilcoxon test, will be applied. Finally, the empirical findings will be summarised before proceeding to the discussion of these results. In order to keep this section tidy as well, it will include only the most vital result tables, while the rest of the tables are presented in Appendix 8.

5.3.1 R&D activities and recessionary performance

First, I investigate how pre-recessionary R&D intensity affects firm performance during recessions by running the second regression model, equation 2. The model is first to run with solely the control variables, followed by the full model with the focus variable R&D to total assets intensity for the financial year 2007. The regression results are shown in Table 5.7 respectively Table 5.8.

Controls Only	ROA		EBITDA Margin		Sales Growth		Tobin's q	
	2008	2009	2008	2009	2008	2009	2008	2009
Control Variables								
Debt Ratio	-.029	-.343*	-.016	-.368***	0.022	0.182	0.128	-.661
	(0.121)	(0.174)	(0.127)	(0.102)	(0.316)	(0.212)	(0.524)	(0.725)
Cash Ratio	-.397*	-.162	-.225*	-.235*	-.182	0.049	1.090	1.338*
	(0.232)	(0.313)	(0.133)	(0.119)	(0.335)	(0.294)	(0.786)	(0.728)
FA/TA	0.016	0.215*	0.227*	0.229	-.139	0.084	0.109	0.411
	(0.116)	(0.114)	(0.122)	(0.174)	(0.249)	(0.267)	(0.574)	(0.599)
Size	0.023	0.043**	0.022**	0.030*	0.010	0.017	-.016	0.020
	(0.016)	(0.020)	(0.010)	(0.016)	(0.019)	(0.018)	(0.056)	(0.050)
Firm Age	-.009	-.009	-.001*	-.001	-.041	0.027	0.188	0.108
	(0.026)	(0.029)	(0.022)	(0.020)	(0.033)	(0.039)	(.114)	(0.134)
Constant	-.086	-.192	0.044	0.189	0.185	-.358	0.304	0.943
	(0.128)	(0.193)	(0.148)	(0.203)	(0.268)	(0.318)	(0.845)	(1.058)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	86	83	83	85	86	84	84
R-Square	0.458	0.369	0.353	0.504	0.353	0.224	0.336	0.261
F-value	3.428	2.344	2.086	3.884	2.146	1.158	1.969	1.368

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 5.7 Pre-recessionary R&D activities, control model results

Running the first regression model with only the control variables offers rather decent explanatory power with ROA and the EBITDA margin having the highest R^2 between 37% and 46%, respectively 35% and 50%. However, for sales growth and Tobin's q the regression model is significant only for the year 2008, while the explanatory power and regression significance drop considerably in 2009.

Then, adding the focus variable R&D intensity, as shown in Table 5.8 and Appendix 8.1, increases the explanatory power considerably for the different regressions. The only exception for this is the model for sales growth in 2009 that still demonstrates an insignificant F-value. Using R&D intensity to total assets increased the R^2 of ROA to between 43% and 54%, while the EBITDA margin had a humbler increase to between 37% and 50%. For sales growth this focus variable increased R^2 from between 22% and 35% to between 25% and 42%. The biggest change, although, was for Tobin's q where the explanatory power increased from between 26% and 34% to between 38% and 54%. Examining in turn how R&D intensity to total sales changed the explanatory power when compared to the change R&D intensity to total assets had, the effect was near identical for ROA, clearly superior for the EBITDA margin, marginally superior for sales growth, and inferior for Tobin's q.

Full Model	ROA		EBITDA Margin		Sales Growth		Tobin's q	
	2008	2009	2008	2009	2008	2009	2008	2009
Focus Variable								
R&D/TA 2007	-.779	-.529	-.461	0.048	-1.401**	0.086	4.124**	2.720*
Control Variables	(0.209)	(1.270)	(0.733)	(0.525)	(0.692)	(0.772)	(2.012)	(1.370)
Debt Ratio	-.018	-.360*	-.018	-.364***	0.109	0.218	0.030	-.845
	(0.139)	(0.190)	(0.170)	(0.109)	(0.271)	(0.232)	(0.456)	(0.731)
Cash Ratio	-.183	-.096	-.131	-.239	0.105	-.066	0.061	0.685
	(0.187)	(0.300)	(0.227)	(0.145)	(0.342)	(0.400)	(1.182)	(0.866)
FA/TA	0.021	0.216*	0.230*	0.238	-.193	0.076	0.086	0.376
	(0.102)	(0.124)	(0.137)	(0.181)	(0.224)	(0.277)	(0.460)	(0.572)
Size	0.017	0.039**	0.022*	0.031*	0.003	0.018	0.022	0.023
	(0.012)	(0.019)	(0.013)	(0.017)	(0.017)	(0.019)	(0.034)	(0.053)
Firm Age	0.010	0.000	0.002	-.004	-.021	0.028	0.071	0.054
	(0.016)	(0.023)	(0.022)	(0.021)	(0.032)	(0.040)	(0.078)	(0.127)
Constant	-.124	-.193	0.028	0.188	0.121	-.382	0.639	1.320
	(0.125)	(0.193)	(0.174)	(0.204)	(0.255)	(0.331)	(0.787)	(0.987)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85	84	82	82	83	84	82	82
R-Square	0.540	0.429	0.370	0.499	0.415	0.249	0.535	0.377
F-value	4.304	2.716	2.055	3.483	2.520	1.199	4.025	2.119

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 5.8 Pre-recessionary R&D activities, full model results

Measuring pre-recessionary R&D intensity to total assets, a one percent increase in this variable resulted in a 1.4% decrease in sales growth 2008, whilst increasing Tobin's q by 4.1% and 2.7% in 2008 respective 2009. When the R&D intensity is measured to total

sales, an increase of one percent in this intensity resulted in a 0.4% and 0.6% decrease in ROA respective EBITDA margin in 2008.

These results confirm the previously suggested negative relationship between increased R&D intensity and measures of profitability and sales growth, as well as the positive effect on Tobin's q. The limited extent of this negative relationship, however, was surprising as the Pearson's r correlation matrix suggested a significant effect of both R&D intensities on the firm performance indicators for both 2008 and 2009. This lesser degree of significant results is the outcome of the HC3 estimator correcting the heteroscedasticity of the dataset. Nevertheless, these findings support both H1a and H1b, as both a positive as well as negative effect on firm performance during the recession was found to stem from pre-recessionary R&D activities.

5.3.2 Recessionary R&D activities and later firm performance

Now, in turn, the focus shifts to whether R&D that is performed during the recession can affect later firm performance in the post-recessionary period from 2010-2018. As previously mentioned, due to the total sales being severely affected by the demand shock of the recession, R&D intensity in relation to total assets has been chosen as the proxy for measuring the R&D activities during recession. The control models for each firm performance variable during 2010 to 2018 are presented in Appendix 8.2-8.5, whilst the full regression models are shown in Appendix 8.6-8.13. In this subsection, Table 5.9 and Table 5.10 presents the noteworthy, significant findings from 2010 to 2018.

Full Model	EBITDA Margin		EBITDA Margin		ROA		
	2012	2013	2014	2015	2016	2017	2018
Focus Variable							
R&D/TA 2008	-.204	-.979**	-1.071**	-.706	-.687**	-.297	-.146
Control Variables	(0.536)	(0.477)	(0.419)	(0.756)	(0.334)	(0.346)	(0.284)
Debt Ratio	-.384***	-.185	-.084	-.133	-.300	-.400	-.184*
	(0.129)	(0.245)	(0.184)	(0.188)	(0.253)	(0.134)	(0.106)
Cash Ratio	0.068	0.021	0.469	0.132	-.110	-.625**	0.139
	(0.339)	(0.586)	(0.828)	(0.504)	(0.362)	(0.281)	(0.206)
FA/TA	.068	0.179	0.341	0.230	0.263	-.090	0.220
	(0.096)	(0.204)	(0.211)	(0.156)	(0.171)	(0.188)	(0.137)
Size	0.013	0.038**	0.040**	0.032***	0.017	0.004	0.016
	(0.009)	(0.015)	(0.018)	(0.011)	(0.012)	(0.009)	(0.012)
Firm Age	-.020	-.010	-.014	0.027	-.019	0.010	0.001
	(0.023)	(0.028)	(0.028)	(0.034)	(0.024)	(0.021)	(0.021)
Constant	0.467***	0.062	-.029	-.056	0.153	0.292*	-.037
	(0.167)	(0.246)	(0.324)	(0.258)	(0.255)	(0.174)	(0.165)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	81	83	86	85	86	87	87
R-Square	0.486	0.559	0.529	0.492	0.252	0.552	0.376
F-value	3.251	4.509	4.185	3.557	1.255	4.654	2.278

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 5.9 R&D activities in 2008, full model results

First, using R&D to total assets in 2008 as the focus variable, only a few significant effects on later firm performance can be found. An increase of one percent in the R&D intensity to total assets in 2008 decreased the EBITDA margin with 1% in 2013 and with 1.1% in 2014. While a significant effect is shown for ROA in 2016, an F-value of 1.255 implies that the regression itself is not significant, and therefore, this result cannot be considered as statistically robust. The focus variable itself increased the explanatory power most for the regression models involving ROA and the EBITDA margin, whereas Tobin's q had a more modest change, and lastly, sales growth hardly any change at all.

Nevertheless, while the results did show several significant effects between R&D intensity in 2008 and later firm performance, after correcting for heteroscedasticity only the EBITDA margin in 2013 and 2014 remained significant. Still, this lagged effect of up to six years is intriguing and it will be discussed further in the following chapter 6.

Full Model	ROA		Tobin's q		EBITDA Margin	
	2010	2011	2010	2011	2014	2015
Focus Variable						
R&D/TA 2009	-.211	-.527***	2.998***	1.720	-.918***	-.543
Control Variables	(0.345)	(0.196)	(1.135)	(1.146)	(0.228)	(0.503)
Debt Ratio	-.174	-.166*	-1.216	-.566	0.047	0.092
	(0.116)	(0.091)	(0.751)	(0.488)	(0.179)	(0.245)
Cash Ratio	-.070	-.048	-.227	0.548	0.689	0.251
	(0.163)	(0.214)	(1.028)	(0.819)	(0.756)	(0.517)
FA/TA	0.108	-.050	-.244	0.429	0.373*	0.243
	(0.085)	(0.102)	(0.571)	(0.490)	(0.199)	(0.197)
Size	0.024***	0.018*	0.066	0.038	0.044**	0.032**
	(0.008)	(0.010)	(0.066)	(0.048)	(0.017)	(0.012)
Firm Age	0.005	0.015	0.027	0.067	-.016	0.038
	(0.016)	(0.016)	(0.140)	(0.113)	(0.029)	(0.033)
Constant	-.110	-.074	1.561	1.043	-.155	-.250
	(0.113)	(0.125)	(1.145)	(0.914)	(0.281)	(0.314)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	87	85	84	87	86
R-Square	0.455	0.395	0.408	0.419	0.553	0.461
F-value	3.148	2.463	2.524	2.609	4.678	3.189

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Table 5.10 R&D activities in 2009, full model results

Then, after changing the focus variable into R&D intensity in 2009, it was found to affect a broader scale of firm performance indicators than the R&D intensity in 2008. One percent increase in R&D intensity in 2009 increased Tobin's q of the following year by 3%, decreased ROA by 0.5% in 2011, and decreased the EBITDA margin by 0.9% in 2014. This following-year effect on Tobin's q is similar to the one identified in the first regression model, whereas another significant effect on the EBITDA margin in 2014 could indicate the existence of a year-specific effect.

The explanatory power of the regression models using R&D intensity in 2009 compared to the previous ones using R&D intensity in 2008, exhibit quite similar performance throughout the post-recessionary period. These regression results, nevertheless, indicate that the second hypothesis may be accepted to at least some degree. H2a finds support from the negative effects R&D intensity in 2008 had on the EBITDA margin 2013 and 2014, while R&D intensity in 2009 affected negatively ROA in 2011 and the EBITDA in 2014. H2b, subsequently, is supported from the positive effect R&D in 2009 had on Tobin's q in 2010. However, without any seemingly logical trend in these results, the hypothesis can be argued to find only partial support. This will be discussed more in-detail in the following chapter.

5.3.3 Increased R&D activities during recessionary years

To investigate the second research question in whether differences in these recessionary R&D activities could explain differences in post-recessionary firm performance, the last regression model adopts the R&D dummy variable as the focus variable. Then, similarly to the second regression model, regressions are performed on the firm performance variables as the dependent variables, spanning from 2010 to 2018.

Shown in Appendix 8.14-8.17, it can be stated that the performed regressions are unsuccessful, as no significant effects are found between the performance indicators and the dummy variable. Admittedly, ROA in 2015 exhibits a 10 percent significance level with a significant regression model, but as the other results stated in this thesis are significant on at least a 5% level, a ten percent significance is too low to be accepted.

The general fit of the model can also be considered inadequate, as the explanatory power barely increases after adding the focus variable when compared to the control models. In many cases, this explanatory power even decreased from the control models. These findings as a whole, with insufficient indications of significant effects between the variables, do not find support for the third hypothesis. Before fully rejecting the third hypothesis, further analysis will be done with the MWW-test.

5.3.4 Mann-Whitney-Wilcoxon test on firm performance

Examining these results further, I apply the Mann-Whitney-Wilcoxon (MWW) test where the sample is grouped based on the same dummy variable as in the regression above. That is, the firm belongs to group 1 if it increased its RD/TA-intensity during the recessionary years 2008 and 2009 compared to the pre-recession year 2007. The four dependent firm performance variables were then analysed for the same time period 2010 to 2018 as in the regression models.

Firm Performance Indicator		RD/TA+ 2008-2009		MWW	
		1	0	Z-value	p-value
Tobin's q - 2018	Mean	1.47	1.76	-2.046	0.041
	Median	1.15	1.47		
	1st quartile	0.93	1.14		
	3rd quartile	1.95	2.13		
Tobin's q - 2017	Mean	1.67	1.85	-1.934	0.053
	Median	1.35	1.62		
	1st quartile	1.08	1.28		
	3rd quartile	2.06	2.31		

Table 5.11 Mann-Whitney Wilcoxon test, increased R&D intensity 2008-2009

As shown in Table 5.11, the only variable that showed a significant difference among the groups was Tobin's q. On a 5% level of significance this only applied for the year 2018, while on a 10% level this applied for the year 2017. Those that increased their R&D intensity during the recessionary years (median: 1.13; Q1: 0.93 – Q3: 1.95) showed significantly lower Tobin's q values in 2018, compared to those that did not increase their R&D intensity (median: 1.45; Q1: 1.14 – Q3: 2.13) ($U = 625$; $p = 0.041$). Respectively, for those that increased R&D intensity (median: 1.35; Q1: 1.08 – Q3: 2.06) had lower Tobin's q in 2017 than those that did not increase their R&D intensity (median: 1.62; Q1: 1.28 – Q3: 2.31) ($U= 591$; $p = 0.053$). Unsurprisingly, no other financial performance indicator showed a significant difference between the two groups for any year from 2010 to 2018, which further verifies the regression results.

5.4 Summary of findings

In the analysis, I first examined the relationship between pre-recessionary R&D intensity and firm performance during the recession of 2008-2009. Using a regression model with several control variables for the asset-, country- and industry-specific effects, the results showed a significant relationship between pre-recessionary R&D intensity and firm performance during the recessionary time period. This effect was positive for Tobin's q, whilst it was negative for the measures of firm profitability and sales growth. Therefore, there was support for both H1a and H1b.

Following these results, I analysed whether R&D intensity during the recession could affect firm performance post-recession. Both R&D intensity during 2008 and 2009 were measured separately, providing varying results throughout the time period of 2010-2018. Firstly, R&D intensity in 2008 showed a negative and significant effect on the EBITDA margin in 2013 and 2014. No other variables showed a statistically significant effect on this R&D intensity. Secondly, R&D intensity in 2009 showed a statistically significant, positive effect on the following year's Tobin's q, similar to the pre-recession R&D intensity to Tobin's q during the recession. In addition to this, the R&D intensity of 2009 also showed a negative effect on ROA in 2011 and EBITDA margin in 2014. The latter of these two measures of firm performance was the sole variable and year with a similar, statistically significant, and negative relationship to the R&D intensities during the recession. For this reason, as there was no consistency or trend in the effect recessionary R&D intensity has on later firm performance, H2a and H2b can only be partially accepted. There are indications of a relationship between these variables, but persistent effects throughout the time period cannot be found.

To test this from another aspect, I grouped the firms into two groups based on their R&D activities during the recession; those that increased their R&D intensity both years compared to the pre-recession R&D intensity, and those that did not. This time the explanatory power of the regression model barely increased, often even decreased, indicating that this dummy variable grouping these firms would not affect the firm performance indicators, Accordingly, the only variable to show an effect was ROA in 2015, showing a negative effect, albeit on a 10% significance level. Based on these results, there was no support at all for Hypothesis 3 during this time period of the study.

In order to validate these results further, I chose to run a non-parametric Mann-Whitney-Wilcoxon test, grouping these firms with the same dummy variable used in the regression model above. Among all the firm performance indicators from 2010 to 2018, only Tobin's q showed a significant difference between the two firm groups. This difference only applied for 2017 ($p = 0.053$) and 2018 ($p = 0.041$), were those that increased their R&D intensity during the recession, in fact, showed lower Tobin's q values during in 2017 and 2018 than those that did not increase their R&D intensity.

Regarding the control variables used in the regression models, both the dummy variables controlling for industry and country, as well as the individual measures of other firm ratios showed significant effects on the firm performance indicators. While in many cases the non-dummy variables showed no significance on firm performance, the industry-specific dummy variables had indeed significant effects on the performance indicators; thus, leading into relatively high explanatory power for the model.

Liquidity was negatively related to both ROA and the EBITDA margin during the recessionary years of 2008 and 2009. In the post-recessionary period, liquidity was only significantly affecting ROA in 2017, while the EBITDA margin was unaffected during this time period. Sales growth and Tobin's q were totally unaffected by the firm liquidity level during the whole time period.

Debt ratio did not have an effect on firm performance during the first year of the recession, but a significantly negative effect on ROA and EBITDA margin in 2009. This negative relation on EBITDA margin continued for 2010-2012, with an increasing negative coefficient during the post-recessionary period. The negative effect of increased debt affected ROA only triennially, in 2011, 2014 and 2017. While leverage had no statistical significance on sales growth during the recession, it showed a significant and negative effect in 2014. Tobin's q showed no significant relationship to the debt ratio in the study.

The fixed assets ratio appeared to have a weakly significant, positive effect on ROA in 2009 and the EBITDA margin in 2008. This positive effect on ROA only appeared in 2018 during the post-recessionary period. It was also evident for the EBITDA margin in 2014, 2016, and 2018, albeit with a decreasing positive coefficient. Interestingly, the fixed assets ratio had a significant and negative effect on sales growth in 2015 – the sole

year during the whole studied time period. Tobin's q showed no significant relationship to the fixed assets ratio during the time period studied.

Firm size depicted a positive effect on ROA in 2009 and EBITDA margin 2008 and 2009, indicating that larger companies could upkeep profitability better during the recession than their smaller rivals. This positive effect on ROA continued in the post-recessionary time period as well, with the only exceptions being 2016 and 2017 without significant effects. EBITDA margin had the same positive relationship to firm size throughout most of the post-recession time period, omitting the missing statistical significance in 2011-2012 and 2017. Firm size affected sales growth only in 2015, showing a significant and negative relationship between the variables. Lastly, Tobin's q was once again missing a statistical significance to the control variable during the whole time period.

Firm age proved not to affect firm performance to such an extent that was expected, as the variable showed significance only on two occasions. Firstly, it showed a minimal negative effect on the EBITDA margin in 2008. Secondly, it had a positive and significant effect on ROA in 2014, albeit in neither case on a 5% significance level. Despite this, it was motivated to include the firm age in the regressions, as it increased the explanatory power in all of the models.

6 DISCUSSION

The purpose of this chapter is to discuss the analysis results from the previous chapter while reflecting on the strategic and financial theory presented in unison with prior research. Secondly, I will review the theoretical implications of my findings and their relevance to future studies. This chapter will lastly outline the limitations and weaknesses of this study, discussing the implications of these choices.

6.1 Discussion of analysis results

This section discusses the results from the quantitative analyses, as well as it contemplates the used variables and the quantitative model itself. First, the implications of the chosen focus variable are deliberated. Then, the focus shifts towards the different time periods in the study, discussing the possible firm dynamics that resulted in these findings. Finally, the quantitative model and chosen actions related to it are scrutinised.

6.1.1 Linking R&D activities and firm performance

Evaluating the used proxy for R&D activities of the firm, the R&D intensity is based purely on accounting figures, indicating often higher costs for the firm when R&D intensity is increased, unless there has been a decrease in the denominator that is either total sales or assets. As the sales figure proved itself to be more volatile due to the demand shock caused by the recession, it was only used when measuring pre-recessionary R&D intensity in relation to firm performance during the recession. However, the very nature of this proxy, indicating higher costs for the firm at higher levels of R&D intensity, may be the very reason for the mainly negative relationship to firm performance, as stated in the results chapter.

Furthermore, it can be speculated if this very aspect of measuring R&D as merely a cost for the firm, could result in a short-term effect on the accounting-based measures of firm performance. Sustained or time-lagged effects of the R&D intensity of a single year, however, could be argued to indicate more asset-specific effects of R&D activities, rather than seeing the variable as simply an increased cost for the firm. Yet, this also opens up the possibility that the R&D intensity of one year is nearly identical to the year that demonstrates a significant effect on firm performance, as firms often smooth their R&D

costs over time (Coad & Rao-Nicholson, 2010). This would imply the possibility of multicollinearity issues between the R&D intensities of these years, and therefore, result in a falsely significant effect on firm performance for the latter year. While this certainly is a possibility that cannot be excluded when discussing the findings of this thesis, I attempt to offer other explanations for these significant results based on the theories and prior research presented.

Pre-recessionary R&D and recessionary performance

Described in the summarisation of the findings, there was support for the first hypothesis regarding a relationship between the R&D activities before the recession and the firm performance during the recession. This relationship was found to be negative for the past-oriented measures on sales growth and profitability, whilst the market-related and forward-looking Tobin's q exhibited a positive relationship to increased R&D intensity.

Higher pre-recession R&D intensity, in relation to sales, indeed led to worse ROA during the recession, resulting in similar findings as Latham and Braun (2008) found in the United States. Their findings imply that these firms also recover faster from the economic shock, which is also indicated by the regression results in this thesis where R&D intensity 2007 had a positive relationship to ROA in 2009, albeit the result proved to be insignificant. This opposes the other results that I found when R&D intensity was measured in relation to total assets – demonstrating a negative relationship to ROA throughout the whole time period. Admittedly, the sample that Latham & Braun (2008) used consisted of a quintuple amount of firms from a single industry, making their results more robust than the smaller sample used in this thesis.

As to why higher R&D intensity pre-recession led into worse firm performance during the recession, there are a few possible aspects to consider for. First, whereas firms commit themselves in investing into projects, there are often projections made of estimated future earnings of these projects – a positive NPV leading into profitable investment opportunities, whereas those projects with a negative NPV are not worth pursuing for, as they would result in a net loss for the company to invest in. These pre-recessionary R&D projects may be estimated with such future earnings projections that do not account for a sudden economic shock, leading unexpectedly to unprofitable projects. This, in turn, would cause underperformance during the recession. For this assumption to be plausible, although, a nearly imminent, following-year effect should exist for the relationship

between R&D intensity and firm performance. With findings that indicate the existence of such effect, it certainly is plausible, although, not certain without further analysis.

The second possible explanation for this negative relationship would stem from the pre-recessionary firm characteristics that Knudsen (2019) mentions in his paper. He finds that firms with high pre-recession sales growth are hit harder than those that exhibit lower growth, arguing that the firm may have attracted a high share of marginal customers during the preceding economic boom, which are then lost as the economic shock occurs. These customers may have participated in the market at a late stage of the economic expansion, possibly due to highly cyclical products or services, or alternatively, due to a new, innovative product or service that the firm has introduced to the market (Knudsen, 2019). Unfortunately, to account for pre-recessionary sales growth would require accounting data two years before the recession, as opposed to the one year available in this dataset.

A third, possible explanation for this negative relationship may derive from the high adjustment costs of R&D that were discussed in the theory chapter. As Coad and Rao (2010) found in their paper, firms tend to smooth out their R&D costs over time to minimise fluctuations or interruptions in the process. This tendency of firms to shield their R&D investments was also reported by Knudsen and Lien (2019), indicating that firms may rather turn towards using external financing during an economic shock than make cuts to their R&D processes. This, in turn, may lead to a worse firm performance at the hand of two effects separately, or in the worst case, through the combination of both effects. First, firms may suffer from debt overhang problems, where the firms that already have high levels of leverage, may have issues attempting to acquire even more debt. Second, if these firms that seek external financing have inadequate collateral for debtors, the usage of R&D projects as collateral would indicate a riskier alternative for banks, as the projects are often highly firm-specific and the salvage value for these projects may be zero. It is shown in Table 5.5 that increasing R&D intensity is negatively correlated to the ratio of fixed assets, which banks regularly accept as collateral. Both effects, in turn, may lead to higher interest rates for the firm, which would negatively impact firm performance. However, this can be expected to mostly affect performance measures relating to the bottom line, such as ROA, as the EBITDA margin excludes interest costs when calculated.

R&D during recession and later firm performance

Having discovered a negative relationship between the R&D intensity pre-recession and recessionary firm performance, the focus now shifts toward the recessionary R&D activities of the firm, and how these relate to firm performance post-recession. Rather than demonstrating superior firm performance post-recession as reported by Latham and Braun (2008), higher R&D intensity is found to lead to inferior post-recessionary performance regarding profitability. These results match the findings of Ratvik and Svergja (2016) from the Norwegian market during the same period, however, though only spanning to 2012.

Similar to the previous regression, R&D intensity shows a significant and positive relationship to Tobin's q of the following year. Unlike the previous results, none of the other performance indicators exhibit similar following-year effects, as they did during the recession. Instead, ROA demonstrates a two-year lag similar to the previously reported lag by Lome et al. (2016), and even more surprising, the EBITDA margin demonstrates a time-lagged negative effect of up to six years. Also, rather unexpectedly, sales growth does not indicate any significant effects for this whole post-recessionary period.

This similarity in the negative relationship between R&D and firm profitability as in the previous regression begs to question the direction of the relationship between these variables. Do those firms that exhibit worse firm profitability partake in higher levels of R&D activities, or do R&D-intense firms, simply perform worse than their competitors? The process of research and development is complex, with anticipations of improvement in the competitive advantages of the firm in the form of either knowledge or tangible products, albeit there is no guarantee that the output is fruitful for the firm. There is neither any certainty that these R&D-intense firms are actually good at research and development, whereas the firms may, in fact, be forced to innovate.

Ratvik and Svergja (2016) suggest that this pressure to innovate might result from both general market pressure from rivalling firms, as well as from investors. This pressure to innovate might result in firms partaking in these research and development activities only in order to fulfil these expectations, rather than being a result of a systematic innovation strategy of the company. Listed firms that perform poorly might be especially prone to this kind of pressure – as investors expect the firm to improve their performance through new product offerings, services, or the organisation as a whole. This explanation certainly

seems plausible, as an increase in the R&D intensity of the firm resulted in a significant positive effect on Tobin's q in the following year, suggesting that the market appreciates firms partaking in the research and development activities. Furthermore, as this effect was visible both regarding pre-recessionary R&D and recessionary Tobin's q, as well as for recessionary R&D and post-recessionary Tobin's q, there are indications that this relationship may exist throughout the business cycle.

Examining the overview of these findings from the second regression model, however, result in more questions than answers. Granted, there are significant relationships between the R&D intensity during the two years of recession and post-recessionary firm performance, albeit the inconsistency of the significances and the lack of a noticeable trend in these relationships appears enigmatic. Having accounted for both country- and industry-specific effects through the use of dummy variables, there may exist specific year effects that could not be accounted for, requiring further investigation into.

Nevertheless, having found support for the first two hypotheses, the findings from the third regression model oppositely found no support for the third hypothesis. The chosen dummy variable for measuring the increase or decrease in R&D intensity during the recession proved itself to be a lacklustre fit, as the explanatory power of the model stayed unchanged or in some cases, even decreased. Investigating into this, there are a few possibilities for these insignificant results.

First, there is naturally the concern of using this highly simplified dummy variable as a proxy for measuring whether the R&D activities of the firm increased or decreased during the recession. Even a minuscule increase in the firm's R&D intensity for both 2008 and 2009 would result in the firm being in the group that was theorised to adopt a countercyclical strategy (Knudsen & Lien, 2019), opposed to those firms that would have to decrease their R&D activities due to the recessionary shock. Firms could have been included in this "superior" group merely due to having a low R&D intensity in the single pre-recessionary year 2007 compared to their normal R&D intensity, or alternatively, by only keeping the same R&D intensity as in 2007, but having a decrease in their total assets. Such small changes could distort the intended composition of the firms included in the group, and thereby, affect significantly the regression results.

The second possible cause for the insignificant results is also related to the adopted variable for R&D, relating to the previously discussed weaknesses in using a purely cost-based proxy for such a complex process as research and development. It would be a naïve assumption to expect higher levels of R&D intensity translating simply into better firm performance, rather than assuming that not all R&D is born equal. It is very much related to being able to keep the customer focus as the primary driver for new, innovative products and services, in order to be able to link these activities into possibly superior firm performance. Still, there is also the knowledge developing capability of R&D, resulting in R&D activities, in general, being able to develop unique, rare, immobile, and inimitable resources for the firm – characteristics that are likely to result in improved firm performance, according to Lome et al. (2016). Whether R&D intensity, as a measure of costs for the firm, is an appropriate representation of this highly complex process, is debatable.

Third, there is also the possibility of the insignificant findings being a result of the chosen time period, geographical area, or firm sample for the study. As this study only covers the recession of 2008 to 2009, analysing a different time period might result in opposite results. Similarly, markets in Norway and Finland might share similar, underlying effects that cause insignificant results. Lastly, it might also be purely due to the chosen small firm sample, resulting in a similar trend of insignificance specifically for these 90 listed firms. These possibilities cannot be confirmed or denied unless replicated studies are performed with variations regarding the period of the study, geographical coverage, or the firm sample.

Interestingly, while the third regression model failed to provide statistically significant results regarding differences in later firm performance among the firms that increased their R&D intensity during the recession, and those that did not, the Mann-Whitney-Wilcoxon test succeeded in this. The statistically significant results applied merely on Tobin's q for 2017 and 2018. This result had another even more interesting aspect than only the fact that it provided different results regarding the significance than the regression analysis. Surprisingly, those that increased their R&D intensity during the recession actually exhibited lower Tobin's q values than the firms that acted oppositely during the recession. In all of the regression models, the R&D intensity demonstrated a positive relationship to Tobin's q, while the MWW-test suggests an opposite relationship

between the two variables. However, I believe there exists a logical explanation for the difference in the test results.

This stems from Tobin's q being an indicator of the anticipated growth opportunities of the firm (Chappell & Cheng, 1982), in addition to Tobin's q being a suitable measure studying whether investors acknowledge the research and development activities of the firm, despite often only a minor part of the expenses are actually being capitalised annually. For firms that display a high Tobin's q, the former function of the ratio would translate into high expected growth opportunities – a characteristic that could be linked to smaller, younger firms that are not as established on the market as their counterparts. Reflecting back on the theory, recessions cause financial constraints and demand shocks for firms; thus, the R&D activities are severely dependent on the internal financing capabilities of the firm (Knudsen & Lien, 2014). This accentuated positive correlation between liquidity and the R&D activities would imply that in order for firms to being able to increase their R&D intensity during a recession, they should demonstrate financial stability to some degree as well as have excess capacity in terms of personnel – a feat that could be described being possible for larger and more stable, incumbent firms. This, in turn, would explain the results from the MWW-test, as larger incumbent firms might hold lower Tobin's q values than their smaller counterparts that might have higher anticipated growth opportunities priced in their market valuation. This theory does not, however, explain why this difference in Tobin's q was significant only for the years 2017 and 2018.

6.1.2 Quantitative model and used variables

As with any quantitative model measuring firm performance, it is impossible to entirely eliminate the different aspects that affect how firms perform. While this study managed to capture some of the inference through the abundant usage of control variables, it did not manage to acquire as significant effects between these variables as related studies (cf. Ratvik & Svergja, 2016). Nevertheless, this may stem from using a comparatively small sample with the addition of several significant industry-level effects that the industry dummies succeeded to capture. The model can still be considered relatively successful, as by eliminating these inferences caused by industry- and asset-specific effects the focus variables were found to demonstrate significant effects on the dependent variables while showing satisfactory levels of explanatory power.

As an exception, the quantitative model exhibits a generally low explanatory power when measuring sales growth, indicating a lack of fit for measuring this variable of firm performance with the chosen focus variable and control variables. The sole years that demonstrate significant regressions were 2008, 2015, and 2016, whereas the remaining years fail to do so. This would, in turn, indicate specific year-effects for these three years that show significance, whilst the remaining years show a more accurate picture of the general fit of this model. Admittedly, there are some improvements that could be done to correct this in future studies. One such example could be including control variables that account for eventual inorganic growth, resulting from firm activities within mergers and/or acquisitions, which may impact sales growth considerably when measuring on an annual basis.

Lastly, as the dataset as a whole exhibited heteroscedasticity, there was the alternative of either transforming the data further or to use heteroscedastic-consistent standard errors. Due to the nature of the data, a transformation was not a viable option, as it included many negative coefficients, so the latter option was chosen instead, to reach valid regression results by using the HC3 estimator. The HC3 estimator, however, while correcting for heteroscedasticity in the standard errors, may result in more conservative results regarding the statistical significance of the tests (Brown, 2014; Cattaneo, Jansson, & Newey, 2018). Rather than this being a problem, it further increases the reliability of the results of this study.

6.2 Theoretical implications and outlook for future studies

This study, due to its multidisciplinary approach, offers a multitude of abundant possibilities for future research both within the aspects of firm performance, as well as into the strategical choices of firms that are done during specific time periods. It can also be known as the first study measuring the firm performance impact of the R&D activities of Finnish public companies during recessions, as well as the first known study to combine Norwegian and Finnish data when analysing the R&D activities of public companies.

Findings in this thesis add to the scarce collection of prior research that opposes the general, positive relationship between innovation and firm performance (Latham & Braun, 2008; Ratvik & Svergja, 2016). The probable key aspects here are the differences

in how innovation and R&D are measured, resulting in varying findings regarding this relationship between R&D and firm performance. Nevertheless, by adopting a multitude of various measures for R&D and innovation in diverse contexts, it can be argued to lead to better insight into the specifics when compiling these studies into a greater assembly. Therefore, rather than resulting in definitive answers regarding this relationship between firm performance and the R&D activities during recessions, this study opens the door for additional aspects for future studies to research into.

One such aspect is replicating this study, but rather than applying solely quantitative measures on firm innovation, use a combination of both qualitative and quantitative data. Having a deeper knowledge of the firms' actions during recessions through the usage of, for instance, survey data with ranking questions on the recessionary impact on firm operations. This data could further be applied in unison with patent data, offering insight into the actual output of the R&D activities of the firms. Applying qualitative measures may enable more diverse grouping of the firms and offer as such deeper knowledge in the exact drivers behind how R&D activities impact different measures of firm performance, given that the firm sample is abundant enough for robust results.

If one still chooses to pursue this question from a purely quantitative aspect, it could be of interest to differentiate between the capitalised development and the expensed research costs and determine which of these two cost types act as the driver on firm performance. As the criteria for capitalising development costs are strict, requiring the output to be able to generate future economic benefit, the relationship between the capitalised costs and future firm performance should in theory be positive – opposed to the negative relationship found in this thesis. Similarly, the expensed research costs found on the income statement should exhibit a negative relationship to firm performance, as measures of firm performance often relate to the bottom-line of the income statement. Whether these assumptions prove to be true, is left for future research to explore.

Furthermore, when comparing this thesis to prior research related to recessions, it can be seen as a relatively long study covering a time period of 11 years, whereas many related studies cover shorter timespans. This longer time period provided the means to examine whether R&D activities had longstanding effects on firm performance, as prior research has found time-lags of approximately two years (Lome, Heggeseth, & Moen, 2016; Pakes & Schankerman, 1984). Lagged effects of up to six years between the variables could be

identified, albeit, with a lack of unison or trend in the results as a few, seemingly random years showed significant effects. Therefore, there are indications of many interesting year-specific effects that could be studied further, as these were not accounted for during the post-recessionary time period in this thesis.

Lastly, amidst the current disarray in the business sector that is caused by the impact of the novel coronavirus, there has grown concerns among nations how to prevent the seemingly unavoidable wave of bankruptcies, as firms have been hit by an unprecedented demand and supply chain shock. This has led governments to choose varying approaches to support the funding of these firms, in the hope to prevent bankruptcies of otherwise financially healthy companies. One example of such funding is the *Funding for Business Development in Disruptive Circumstances* that Business Finland offers to Finnish mid-cap companies and SMEs that fulfil certain firm size criteria. This maximum funding of 100 000€ is aimed to support the product development processes of these firms during the crisis (Business Finland, 2020). As previously discussed, there is no guarantee that the research and development processes of the firm are fruitful and successful, leading automatically to improved firm performance. This is especially noteworthy in a situation like the current one, where firms are seemingly *forced* to innovate, in order to be eligible for financing. Therefore, it can be disputed if this is the most effective use of financial support for companies that suffer from a market and supply chain shock? If, and how this financing actually supported the firms over this crisis of as yet unknown duration, is something that future research may find intriguing investigating further into.

6.3 Limitations of the study

Even though the analysis found a significant relationship between prior R&D activities and later firm performance, there are still some concerns regarding the limiting choices made in the study. First, the research and development activities of the firm were measured as a proxy through accounting figures of expensed and capitalised spending, in relation to total assets. This simplified viewpoint on a complex intangible asset, without differentiation between the different types of firms' innovation activities, treats all R&D activities as the same. Access to alternative data, in the form of patents would although have been expensive and this proxy for R&D had been used in earlier research, and thus, chosen for this study as well. Furthermore, as the measurement of R&D intensity

combined both capitalised and expensed R&D spending, separating these two for the analysis might result in differing results.

The second issue concerns using a single year as the measurement of pre-recessionary firm activities. Including a three-year period or even a five-year period before the recession could ensure a higher validity on the accuracy of a firm's activities, instead of a single-year snapshot. This cut-off was still necessary, as accounting data for earlier years were unavailable for many firms in the sample from the sources available to the author.

The final concern is the selection issue for the sample, as including only public companies in the study led to relatively small sample size. Examining private firms as a control group in comparison to public companies could have offered greater insight into the strategic choices of these companies. Regrettably, due to the earlier mentioned data availability this was not possible to conduct in a desirable manner. Also, because of time limitations and the intense labour that was required to manually gather the data, this led to the exclusion of the initially included public companies in Sweden and Denmark.

7 CONCLUSION

The purpose of this thesis was to analyse whether differences in firms' research and development (R&D) activities could explain differences in firm performance, from the viewpoint of strategic actions that are done during recessionary periods. It also briefly presented the accounting dilemma regarding R&D treatment and studies that have shown support for changes to be made to it. The three developed hypotheses were to test how R&D intensity affects firm performance during the recession and after the recession. The analysis of firm performance, measured as sales growth, profitability, and market valuation, was done in unison with several other explanatory control variables that are known to affect firm performance. The empirical analyses were executed using panel data.

The empirical findings of this thesis suggest a significant relationship between firms' pre-recessionary R&D intensity and firm performance during the recession. This relationship was negative for measures of profitability and sales growth, whilst it was positive for market valuation. Interestingly, R&D intensity in relation to total assets showed a significant effect only on Tobin's q and sales growth, while R&D intensity to sales had a significant, negative effect on ROA and the EBITDA margin. These results still support some of the previous empirical findings where R&D and innovation are negatively linked to firm performance, although the adopted measure for R&D varies among the studies.

Continuing this, it was of interest to examine if R&D intensity during the recession could affect firm performance later, as previous studies have found approximately a two-year lag before an effect was identified. Indeed, while the following year effect was found for Tobin's q, ROA exhibited a two-year lag on R&D intensity in 2009 and the EBITDA margin exhibited a four- and five-year lag after the recessionary R&D intensity. Increased R&D intensity had yet again a negative relationship to the profitability ratios and a positive relationship to Tobin's q. Nevertheless, while these results were not consistent and did not exhibit a trend throughout the post-recessionary period, there are indications of a relationship between recessionary R&D activities and later firm performance.

As recessionary R&D intensity proved to affect later firm performance, differences in firms' R&D activities may explain later firm performance differences. Examining this, although, proved to offer insignificant results. While there are theoretical implications

that involuntarily budget cuts in research and development activities may result in long-lasting, negative effects for the firm, measuring this through quantitative, accounting data turned out to be unsuccessful. This corroborates the need for alternative measures of R&D activities in future studies, to pursue this research question further. Examples of these measures could be in the form of qualitative survey data on firms' innovation activities, or alternatively by including data on firm-specific registered patents.

Even though R&D intensity calculated with accounting data is a highly simplified measurement of such a complex, elusive process, this thesis achieves to find it to be linked with future firm performance. The negative relationship was still quite surprising, as the innovation process of firms is generally seen from a value-building, positive aspect. Yet, as also seen in Nokia's case, a high R&D intensity does not automatically translate into a positive impact on firm performance, if the customer focus is lost. It is therefore of utmost importance to view the impact of firms' strategical choices on firm performance from a broader point of view, encouraging future multidisciplinary studies.

Despite its limitations, this thesis offers fertile ground for future research on the strategic choices of firms during periods of recession and these actions' implications on firm performance. This is especially relevant, as the world is facing a seemingly unavoidable global recession as a result of the coronavirus pandemic. On the one hand, this pandemic might result in an unprecedented technological leap, where innovative and adaptable firms can build themselves sustained competitive advantages. On the other hand, fundamental changes in consumer behaviour may be imminent, forcing firms to adapt accordingly in their strategic choices or risk their very existence in the future.

8 SUMMARY IN SWEDISH

FoU-aktiviteter under recessioner: implikationer på nordisk företagsprestanda

Vad orsakar skillnaderna i hur företag presterar i relation till varandra och varför presterar vissa företag bättre än andra över en längre tidsperiod? Förståelsen för hur man skapar hållbara, långsiktiga konkurrensfördelar har varit en av de centrala frågeställningarna inom strategiforskning (Levinthal, 1995). Strategilitteraturen på 1980-talet fokuserade på de externa faktorer som påverkar företagsprestanda – resulterande i bland annat en av de mest kända modeller inom strategin, Porters femkraftsmodell (Porter M. E., 1985). Detta fokus skiftade under 1990-talet mot interna faktorer och hur dessa kan utnyttjas för att uppnå konkurrensfördelar.

RBV (Resource Based View) baserar sig på företagens heterogenitet, eftersom resurserna och förmågan att nyttja dessa resurser varierar bland företag, vilket leder till skillnader i hur företag presterar (Barney J. , 1991). För att resurser ska bidra till hållbara konkurrensfördelar, anser Barney (1991; 1997) att de behöver vara värdefulla, unika, inneha förmågan att motstå imitation samt inte kunna substitueras. Dessa karakteristika är starkt kopplade till företagets immateriella tillgångar, eftersom dessa företagsspecifika tillgångar ackumuleras internt och således antar en mer komplex, abstrakt form som är svår för konkurrenter att imitera (Dierickx & Cool, 1989).

Forskning och utveckling (FoU) kan anses vara en av de centrala immateriella tillgångarna för att skapa ekonomisk tillväxt och ökad konkurrenskraft (Chan A. L.-C., 2012). FoU är en uttalat företagsspecifik tillgång eftersom den är nära bunden till humankapitalet inom företaget och exempelvis kan skyddas mot imitation genom patent. Trots att tidigare forskning bevisat ett positivt samband mellan innovativa aktiviteter och företagsprestanda, finns det ingen garanti för att FoU-processen är framgångsrik och leder till garanterad tillväxt i exempelvis försäljning för varje företag. Denna osäkerhet kring FoU-processens slutprodukt samt dess företagsspecifika natur bidrar till att företag föredrar att finansiera FoU-aktiviteter internt, eftersom extern finansiering skulle vara ett dyrare alternativ (Czarnitzki & Hottenrott, 2011).

Redovisningen av FoU-aktiviteter har dock bemötts med kritik, eftersom redovisningsstandarderna grundar sig på lätt föråldrade antaganden om hur dessa aktiviteter saknar en påvisad koppling till förväntade framtida ekonomisk nytta (Lev B. ,

2019). Under US GAAP är detta synsätt mera strikt än under IFRS – den förstnämnda kostnadsför huvudparten av FoU-utgifterna, medan dessa kostnader inom IFRS kan kapitaliseras under strikta kriterier. Som ett resultat av detta kritiska synsätt på hur FoU-utgifter ska redovisas uteblir en del av det värde som FoU-aktiviteter skapar för företaget, vilket i sin tur kan leda till en felprissättning av företagets aktier (Lev, Nissim, & Thomas, 2008; Sougiannis, 2015). För att bidra till helhetsbilden av de FoU-aktiviteter sampelföretagen ägnar sig åt, inkluderar denna studie både aktiverade FoU-kostnader och FoU-utgifter i kalkylerna för företagsspecifik FoU-intensitet.

Denna avhandling avser studera FoU-aktiviteter under ett specifikt tidsintervall i konjunkturer, nämligen recessioner, och hur dessa aktiviteter påverkar företagsprestandan. Tidigare studier har visat att innovativa företag presterar bättre (Knudsen, 2019; Lome, Heggeseth, & Moen, 2016) än sina motparter, medan vissa studier har visat motsatta resultat (Giebel & Kraft, 2019; Ratvik & Svergja, 2016). På grund av den tidigare nämnda tendensen att internt finansiera FoU-aktiviteter kan recessionens kreditrestriktioner och negativa chock på efterfrågan leda till oönskade nedskärningar i FoU-aktiviteter (Knudsen & Lien, 2014). Eftersom de tillgångar som FoU-aktiviteter leder till ackumuleras internt över tid, kan nedskärningar i dessa orsaka långvariga nackdelar i förhållande till konkurrenter som inte tvingas till motsvarande åtgärder. I vissa fall kan företag anpassa en kontracyklisk investeringsstrategi, där överskottskapacitet i personalen används för att stimulera investeringar i humankapital (Knudsen & Lien, 2019).

För att koppla FoU-intensitet till hur företag presterar under och efter recessioner, använder jag mig av fyra olika finansiella mått som representerar olika synsätt på prestanda: tillväxt i försäljning (*Sales Growth*), effektivitet i att omvandla omsättning till kassaflöde (*EBITDA margin*), lönsamhet i förhållande till de totala tillgångarna (*Return on Assets, ROA*) och slutligen Tobins q som anger om marknaden över- eller undervärderar dessa företag i förhållande till deras totala tillgångar.

Baserat på tidigare forskning finns det både positiva och negativa resultat gällande sambandet mellan företagets prestanda och FoU-aktiviteter, när detta har studerats i anslutning till recessioner. Däremot finns det inga studier som klargör ifall det finns ett samband mellan företagets prestanda och FoU-aktiviteter när det gäller nordiska eller

finska företag under recessioner. För att undersöka detta närmare, presenterar jag följande forskningshypoteser:

H1. Det finns ett samband mellan företags FoU-aktiviteter före recessionen och företagsprestanda under recessionen.

H2. Det finns ett samband mellan intensiteten av FoU under recessionen och senare företagsprestanda.

H3. Det finns ett samband mellan ökad FoU-intensitet under recessionen och senare företagsprestanda.

Alla dessa hypoteser har antingen ett positivt samband, *H1a-3a*, eller ett negativt samband, *H1b-3b*.

Syftet med denna avhandling är således tudelat. För det första undersöker jag ifall företags forsknings- och utvecklingsaktiviteter påverkar deras framtida prestanda, med hänsyn till konjunkturer. För det andra analyserar jag om skillnader i dessa FoU-aktiviteter under recessioner kan förklara senare skillnader i företagsprestanda. Tidsperioden som avhandlingen behandlar sträcker sig från 2007 till 2018, där recessionen 2008–2009 ägnas speciellt intresse. Studien begränsar sig till enbart finska och norska börsbolag.

Studien använder ett flertal olika källor för att samla in data eftersom jag inte hade tillgång till mjukvaror så som Thomson Reuters Datastream. Paneldata om företagsbokslut hämtades för de finska företagen delvis från databasen Voitto+ för tidsperioden 2007–2018, och dessa finansiella data kompletterades och säkerställdes med varje företags årsbokslut för samma tidsperiod. För de norska företagen i samplet användes enbart årsbokslut för den finansiella informationen. I de flesta fall hämtade jag aktiepris för dessa listade företag från årsboksluten, och i vissa fall då denna information saknades, från Nasdaqs webbplats, Oslo Børs webbplats, Reuters och Yahoo Finance. Det ursprungliga samplet bestod av 326 företag, varav 130 var finska och 196 norska företag.

För att ytterligare avgränsa urvalet utelämnade jag företag som inte rapporterade utgifter för forskning och utveckling under recessionen 2008–2009, samt de företag som använde sig av brutna räkenskapsår. Detta resulterade i ett slutligt urval på 90 företag, varav 64 var finska börslistade företag och 26 norska börslistade företag. Dessa företag fördelades i 12 olika sektorer, baserat på företagens huvudsakliga näringsgren samt deras

rapporterade ICB-koder (*Industrial Classification Benchmark*). De finansiella siffrorna inflations- och valutajusterades för att för varje företag skapa ett urval som var jämförbart på årsnivå. Utöver detta, raderades avvikande observationer med hjälp av vissa kvalitativt bestämda gränser på nyckeltal i samband med att jag använde den statistiska metoden *Cook's Distance*.

De tre forskningshypoteserna som jag prövade genom att köra tre varianter av OLS-regressioner, som grundar sig på samma grundmodell. De beroende variablerna i regressionsmodellerna är de fyra finansiella måtten på företagsprestanda, medan den oberoende variabeln i fokus är FoU-intensiteten som varierar beroende på modell. För att ytterligare försäkra att fokusvariabeln inte påverkas av industrispecifika effekter eller andra variabler som är kända för att påverka företagsprestanda, kommer kontrollvariabler att användas för att fånga dessa effekters påverkan på regressionsmodellen. Modellerna använder sig av robusta standardfel på grund av möjlig heteroskedasticitet i data. Utöver dessa regressionsmodeller, kommer jag att använda *Mann-Whitney-Wilcoxon* (MWW) testet för att närmare granska hur de företag som ökar sina FoU-intensiteter under recessionen skiljer sig i företagsprestanda senare i jämförelse med de företag som agerar på motsatt vis.

De beroende variabler som inkluderas i regressionerna består av: *Sales Growth* som anger omsättningen under innevarande året subtraherat och dividerat med fjolårets omsättning, *EBITDA*-marginal som *EBITDA* dividerat med omsättningen, *ROA* som nettoresultat plus räntekostnader och dividerat med totala tillgångar och Tobins q som marknadsvärdet av eget kapital plus totala skulder och dividerat med totala tillgångar. Marknadsvärdet av eget kapital anges som aktiepriset på bokslutsdagen multiplicerat med antalet uteliggande aktier. Fokusvariabeln FoU-intensitet räknas ut genom att addera den kostnadsförda FoU-utgiften med den kapitaliserade FoU-kostnaden, varefter denna summa dividerades med antingen omsättningen eller de totala tillgångarna. I den tredje regressionsmodellen antar fokusvariabeln formen av en dummyvariabel, där företag antar siffran 1 (ett) endast ifall de ökar FoU-intensiteten både 2008 och 2009, i förhållande till 2007, och i andra fall siffran 0 (noll).

Kontrollvariablerna som används i studien är: *Firm Size* som den naturliga logaritmen av totala tillgångar eller omsättningen, *Cash Ratio* som kassa och bank dividerat med totala tillgångarna, *Debt Ratio* som förhållandet mellan företagets totala skulder och dess totala

tillgångar, *Fixed Assets Ratio* som materiella tillgångar dividerat med totala tillgångar och slutligen*, Firm Age* som den naturliga logaritmen av företagets ålder år 2018. Dessutom inkluderas två dummyvariabler, där den ena kontrollerar vilket land och den andra vilken specifik industri som företaget tillhör.

Resultaten uppvisar ett signifikant samband mellan företagets FoU-intensitet före recessionen och hur företaget presterar under recessionen. FoU-intensitet mätt i relation till försäljning uppvisar ett negativt samband med EBITDA-marginalen och ROA, medan FoU i förhållande till totala tillgångarna har ett negativt samband med följande års tillväxt i försäljning och ett positivt samband med Tobins q. Därmed kan både H1a och H1b accepteras.

Den andra regressionen finner även signifikanta samband mellan FoU-intensiteten under två år av recession och senare företagsprestanda. FoU i förhållande till de totala tillgångarna 2008 har en negativ effekt på EBITDA-marginalen 2013 och 2014. Samma mått på FoU-intensitet för 2009 har negativ inverkan på ROA 2011 och EBITDA-marginalen 2014, samt ytterligare positiv inverkan på Tobins q 2010. Härmed kan även H2a och H2b accepteras.

Baserat på tidigare forskning och befintlig teori finns det ett antal möjliga orsaker till att detta negativa samband existerar mellan FoU-intensitet och företagsprestanda. För det första har FoU-projekt som påbörjats före recessionen troligen använt sig av lönsamhetsmått som inte beaktat sannolikheten för en ekonomisk kris. Detta har lett till att tidigare lönsamma projekt har blivit olönsamma, vilket resulterade i en systematiskt sämre företagsprestanda. För det andra kan detta negativa samband härledas från de höga justeringskostnaderna för FoU och att företag tenderar skydda sina FoU-investeringar under recessioner (Knudsen & Lien, 2019), och därmed leda till situationer där företag finansierar sin FoU med externt kapital då de drabbas av en ekonomisk kris. Detta i sin tur kan resultera i två separata effekter som kan försämra företagsprestandan. Om företaget lider av skuldöverhäng (debt overhang) eller innehar otillräckliga fysiska säkerheter för banklån, kan dessa orsaker försvåra företagets anskaffning av externt kapital och troligen också leda till högre finansieringskostnader. Märkbart högre finansieringskostnader skulle därmed leda till en försämrad företagsprestanda under recessionen.

Eftersom ett negativt samband infann sig mellan FoU-intensiteten under recessionen och företagsprestanda upp till sex år senare, kan det anses vara väsentligt att ställa frågan: presterar företag med högre FoU-intensitet sämre än sina motparter eller leder en högre FoU-intensitet till en försämrad företagsprestanda? Då FoU-processerna är komplicerade finns det inte heller någon garanti för att dessa FoU-intensiva företag verkligen är duktiga inom FoU, utan de kan i själva verket vara tvingade till att begå forskning- och utvecklingsaktiviteter. Ratvik och Svergja (2016) antyder att företag kan känna sig pressade av investerare och konkurrenter att engagera sig i innovationsprojekt, vilket kan leda till situationer där företag gör detta endast för att uppfylla dessa förväntningar, i stället för att systematiskt skapa en innovationsstrategi för sig själva. Börslistade företag som presterar dåligt kan vara särskilt känsliga för denna press, eftersom investerare har höga förväntningar på att företaget ska skapa nya produkter, tjänster eller förnya organisationen i sin helhet, och således åter öka sin företagsprestanda. Då Tobins q uppvisade ett signifikant och positivt samband med ökad FoU-intensitet tidigare år, ger detta ett intryck av att aktiemarknaden sannerligen värdesätter företagets FoU-aktiviteter.

Däremot uppvisar den tredje regressionsmodellen inga signifikanta samband mellan ökad FoU-intensitet 2008–2009 och senare företagsprestanda. I motsats till de tidigare regressionsmodellerna ökar förklaringsgraden i modellen minimalt eller till och med sänks när fokusvariabeln inkluderas. Således kan inte nollhypotesen förkastas för H3. För att ytterligare undersöka detta används MWW-testet där dummyvariabeln för ökad FoU-intensitet grupperar företagen och analyserar de två gruppernas prestanda på senare tid. MWW-testet finner endast signifikanta skillnader i de två gruppernas resultat för variabeln Tobins q för 2017 ($p = 0{,}053$) och 2018 ($p = 0{,}041$), där de som ökade sin FoU-intensitet under recessionen uppvisar lägre Tobins q för båda åren än den andra gruppen.

Avsaknaden av signifikanta resultat från den tredje regressionsmodellen härstammar möjligen från svagheterna i dummyvariabeln. Minimala förändringar i företagets FoU-intensitet, en lägre FoU-intensitet än normalt för året innan recessionen eller stabila FoU-kostnader under recessionen med sänkta totala tillgångar, kan alla leda till att ett företag blir felaktigt inkluderat i den grupp som i teorin skulle öka sin FoU-intensitet utöver det normala under recessionen. Däremot kan det sannolikt finnas en logisk förklaring till de statistiskt signifikanta resultaten från MWW-testet. Eftersom Tobins q även är en indikator på företagets förväntade tillväxtmöjligheter (Chappell & Cheng, 1982) kan det antas att ett högt värde antyder en hög förväntad tillväxt för företaget, om investerare är

beredda att betala mera för företaget än vad balansvärdet är värt. Högre förväntad tillväxt kan förknippas med yngre och mindre företag, medan större och äldre bolag antagligen kan förväntas växa mindre. Då recessionen orsakar både kreditrestriktioner och en negativ chock på efterfrågan, blir företag allt mer beroende av den interna finansieringen för att kunna finansiera sina pågående investeringar inom bland annat forskning och utveckling. Stora och äldre företag kan ytterligare antas ha bättre likviditet än sina yngre och mindre motparter, som sannolikt investerar sitt kapital på ytterligare tillväxt. Därmed är det tämligen logiskt att MWW-testet uppvisar resultat som indikerar att de företag som kunde öka sina FoU-intensiteter under recessionen också uppvisar lägre Tobins q under perioden efter recessionen. Detta antagande förklarar dock inte varför resultatet var signifikant endast för 2017 och 2018.

Sammanfattningsvis är dessa resultat som indikerar ett negativt samband mellan företagets FoU-intensitet och företagsprestanda ett tillägg till den forskning som bestrider det generellt positiva synsättet på företagets forsknings- och utvecklingsaktiviteter. Trots att jag inte kunde ge ett definitivt svar på hur företagets FoU-aktiviteter påverkar dess prestanda, eller kunde påvisa om skillnader i dessa aktiviteter under recessionen kan skapa hållbara konkurrensfördelar, erbjuder denna avhandling ett brett utbud av möjligheter för framtida tvärvetenskaplig forskning.

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APPENDICES

Appendix 1.

The full list of the companies included in the final sample of this thesis, where the emboldened companies have been manually adjusted to a befitting industry supersector.

Code	Country	Supersector	Company
0500	**FIN**	**Oil & Gas**	**Fortum Oyj**
0500	FIN	Oil & Gas	Neste Oyj
0500	**NOR**	**Oil & Gas**	**Aker BP ASA**
0500	**NOR**	**Oil & Gas**	**Electromagnetic Geoservices ASA (EMGS)**
0500	NOR	Oil & Gas	Equinor ASA
0500	NOR	Oil & Gas	Petroleum Geo-Services ASA (PGS)
0500	NOR	Oil & Gas	REC Silicon ASA
1300	FIN	Chemicals	Kemira Oyj
1300	NOR	Chemicals	Yara International ASA
1700	FIN	Basic Resources	Afarak Group Oyj
1700	FIN	Basic Resources	Ahlstrom Oyj
1700	FIN	Basic Resources	Metsä Board Oyj
1700	FIN	Basic Resources	Outokumpu Oyj
1700	FIN	Basic Resources	Stora Enso Oyj
1700	FIN	Basic Resources	UPM-Kymmene Oyj
1700	NOR	Basic Resources	Norsk Hydro ASA
1700	**NOR**	**Basic Resources**	**Norske Skog ASA**
2300	FIN	Construction & Materials	Glaston Oyj
2300	FIN	Construction & Materials	Tikkurila Oyj
2300	FIN	Construction & Materials	Tulikivi Oyj
2300	FIN	Construction & Materials	Uponor Oyj
2300	FIN	Construction & Materials	YIT OYJ
2300	**NOR**	**Construction & Materials**	**AKVA Group ASA**
2700	FIN	Industrial Goods & Services	Cargotec Oyj
2700	FIN	Industrial Goods & Services	Componenta Oyj
2700	FIN	Industrial Goods & Services	Dovre Group Oyj
2700	FIN	Industrial Goods & Services	Elecster Oyj
2700	FIN	Industrial Goods & Services	Exel Composites Oyj
2700	FIN	Industrial Goods & Services	Huhtamäki Oyj
2700	FIN	Industrial Goods & Services	Incap Oyj
2700	FIN	Industrial Goods & Services	Kesla Oyj
2700	FIN	Industrial Goods & Services	KONE Oyj
2700	FIN	Industrial Goods & Services	Konecranes Oyj
2700	FIN	Industrial Goods & Services	Lassila & Tikanoja Oyj
2700	FIN	Industrial Goods & Services	Metso Oyj
2700	FIN	Industrial Goods & Services	Neo Industrial Oyj
2700	FIN	Industrial Goods & Services	Outotec Oyj

2700	FIN	Industrial Goods & Services	Ponsse Oyj
2700	FIN	Industrial Goods & Services	Raute Oyj
2700	FIN	Industrial Goods & Services	Vaisala Oyj
2700	FIN	Industrial Goods & Services	Wärtsilä Oyj
2700	**NOR**	**Industrial Goods & Services**	**Hexagon Composites ASA**
2700	**NOR**	**Industrial Goods & Services**	**Kongsberg Gruppen ASA**
2700	**NOR**	**Industrial Goods & Services**	**NEL ASA**
2700	NOR	Industrial Goods & Services	Orkla ASA
2700	NOR	Industrial Goods & Services	Tomra Systems ASA
3300	FIN	Automobiles & Parts	Nokian Renkaat Oyj
3300	NOR	Automobiles & Parts	Kongsberg Automotive Holding ASA
3500	FIN	Food & Beverage	Apetit Oyj
3500	FIN	Food & Beverage	Atria Oyj
3500	FIN	Food & Beverage	HKScan Oyj
3500	FIN	Food & Beverage	Olvi Oyj
3500	FIN	Food & Beverage	Raisio Oyj
3500	NOR	Food & Beverage	NattoPharma ASA
3500	**NOR**	**Food & Beverage**	**SalMar ASA**
3700	FIN	Personal & Household Goods	Fiskars Oyj Abp
3700	FIN	Personal & Household Goods	Honkarakenne Oyj
3700	FIN	Personal & Household Goods	Martela Oyj
3700	FIN	Personal & Household Goods	Rapala VMC Oyj
3700	FIN	Personal & Household Goods	Suominen Oyj
4500	FIN	Health Care	Biohit Oyj
4500	FIN	Health Care	Orion Oyj
4500	FIN	Health Care	Revenio Group Oyj
4500	**NOR**	**Health Care**	**Biotec Pharmacon ASA**
4500	**NOR**	**Health Care**	**PCI Biotech Holding ASA**
4500	**NOR**	**Health Care**	**Photocure ASA**
5500	FIN	Media	Alma Media Oyj
5500	FIN	Media	Ilkka-Yhtymä Oyj
5500	FIN	Media	Keskisuomalainen Oyj
5500	FIN	Media	Sanoma Oyj
6500	FIN	Telecommunications	DNA Oyj
6500	FIN	Telecommunications	Elisa Oyj
6500	NOR	Telecommunications	Telenor ASA
9500	FIN	Technology	Basware Oyj
9500	FIN	Technology	Bittium Oyj
9500	FIN	Technology	Digia Oyj
9500	FIN	Technology	Digitalist Group Oyj
9500	FIN	Technology	F-Secure Oyj
9500	FIN	Technology	Nokia Oyj
9500	FIN	Technology	QPR Software Oyj
9500	FIN	Technology	Solteq Oyj
9500	FIN	Technology	SSH Communications Security
9500	FIN	Technology	Tecnotree Oyj
9500	FIN	Technology	Teleste Oyj
9500	FIN	Technology	Trainer's House Oyj
9500	**NOR**	**Technology**	**Funcom Oslo A/S**
9500	**NOR**	**Technology**	**IDEX Biometrics ASA**
9500	**NOR**	**Technology**	**Otello Corporation ASA**
9500	**NOR**	**Technology**	**Q-Free ASA**
9500	**NOR**	**Technology**	**StrongPoint ASA**

Appendix 2.

The inflation values for Norway and Finland that are used in the thesis to adjust the accounting data used for input values. Here the year 2007 has been chosen as the base year.

Inflation, Norway	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inflation, %	0,71 %	3,76 %	2,20 %	2,42 %	1,29 %	0,70 %	2,12 %	2,04 %	2,17 %	3,55 %	1,88 %	2,76 %
Index	100	103,76	106,04	108,61	110,01	110,78	113,13	115,44	117,94	122,13	124,42	127,86
Adjustment factor	1,000	0,962	0,940	0,914	0,900	0,892	0,869	0,846	0,821	0,779	0,756	0,721

Source: Statistics Norway

Appendix 2.1 Inflation and adjustment factor, Norway

Inflation, Finland	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Inflation, %	2,51 %	4,07 %	0,01 %	1,19 %	3,42 %	2,81 %	1,48 %	1,04 %	-0,21 %	0,36 %	0,75 %	1,08 %
Index	100	104,07	104,08	105,32	108,92	111,98	113,64	114,82	114,58	114,99	115,85	117,11
Adjustment factor	1,000	0,959	0,959	0,947	0,911	0,880	0,864	0,852	0,854	0,850	0,841	0,829

Source: Statistics Finland

Appendix 2.2 Inflation and adjustment factor, Finland

Appendix 3.

Currency exchange rates utilised in transforming the accounting data for Norwegian companies. The upmost figures represent the average annual exchange rates, while those below are the year-end exchange rates.

NOK Exchange rates	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
EUR	8,015	8,219	8,729	8,007	7,793	7,474	7,809	8,353	8,953	9,290	9,327	9,596
USD	5,860	5,636	6,282	6,045	5,607	5,821	5,877	6,302	8,074	8,399	8,263	8,134

Source: Norges Bank

Appendix 3.1 Currency exchange rates, NOK-USD NOK-EUR, annual average rate

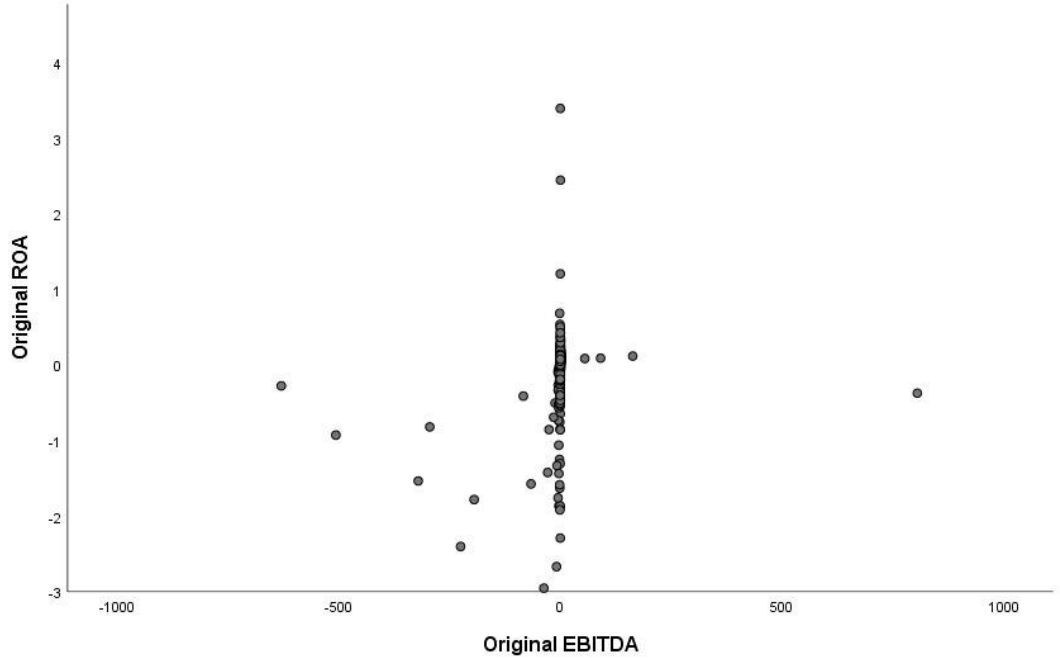
NOK Exchange rates	31.12.2007	31.12.2008	31.12.2009	31.12.2010	30.12.2011	31.12.2012	31.12.2013	31.12.2014	31.12.2015	30.12.2016	29.12.2017	31.12.2018
EUR	7,961	9,865	8,315	7,813	7,754	7,341	8,383	9,037	9,619	9,086	9,840	9,948
USD	5,411	6,999	5,777	5,856	5,993	5,566	6,084	7,433	8,809	8,620	8,205	8,689

Source: Norges Bank

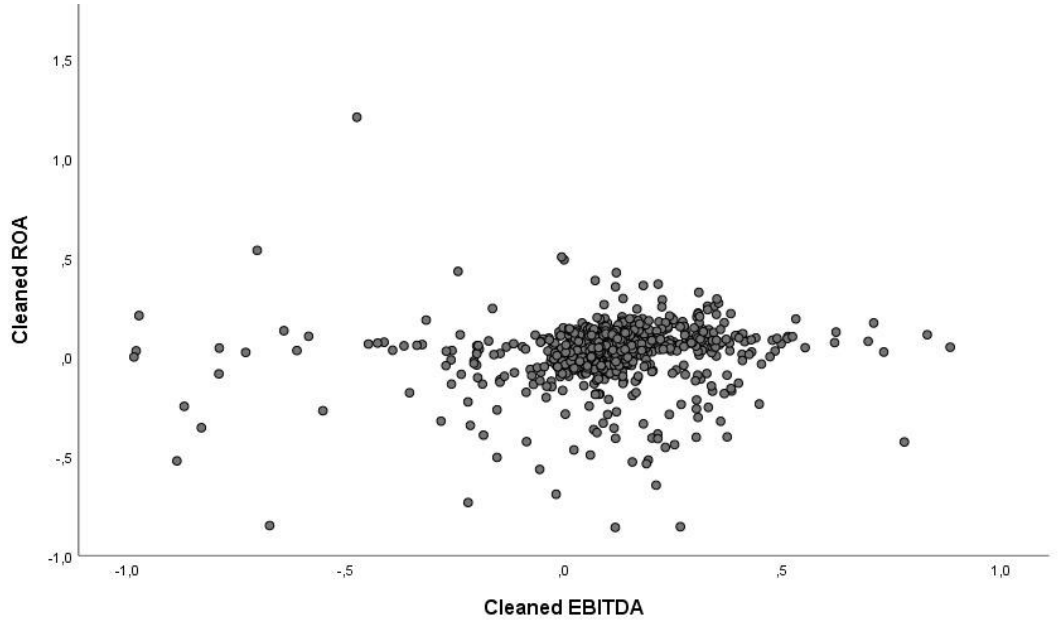
Appendix 3.2 Currency exchange rates, NOK-USD NOK-EUR, year-end rate

Appendix 4.

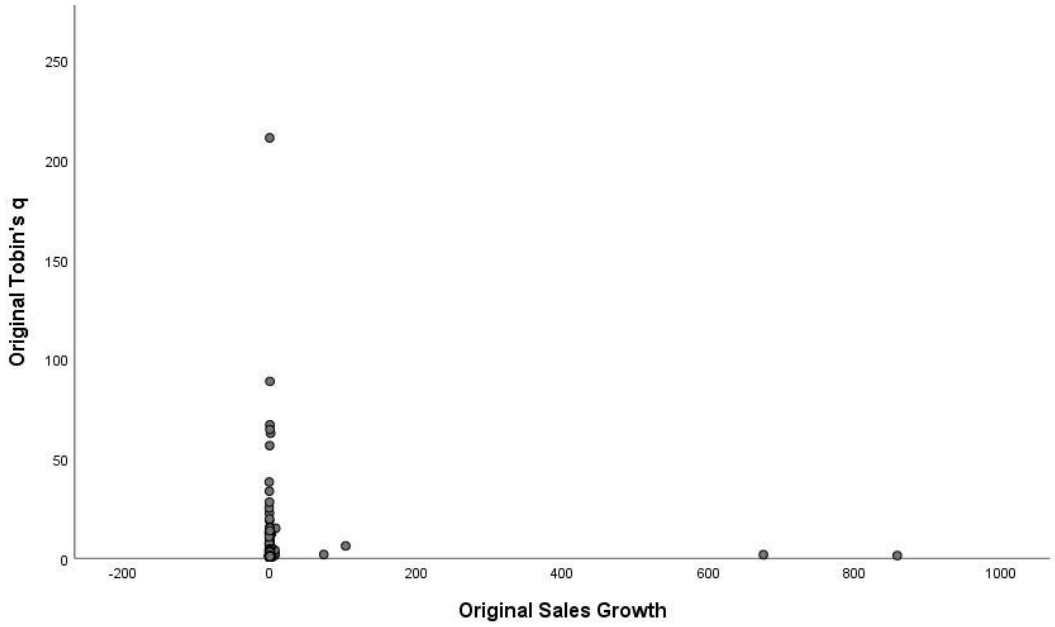
Sample observations distribution of key variables, prior to and after extreme value removal based on the determined qualitative cut-off values shown in Table 4.2.



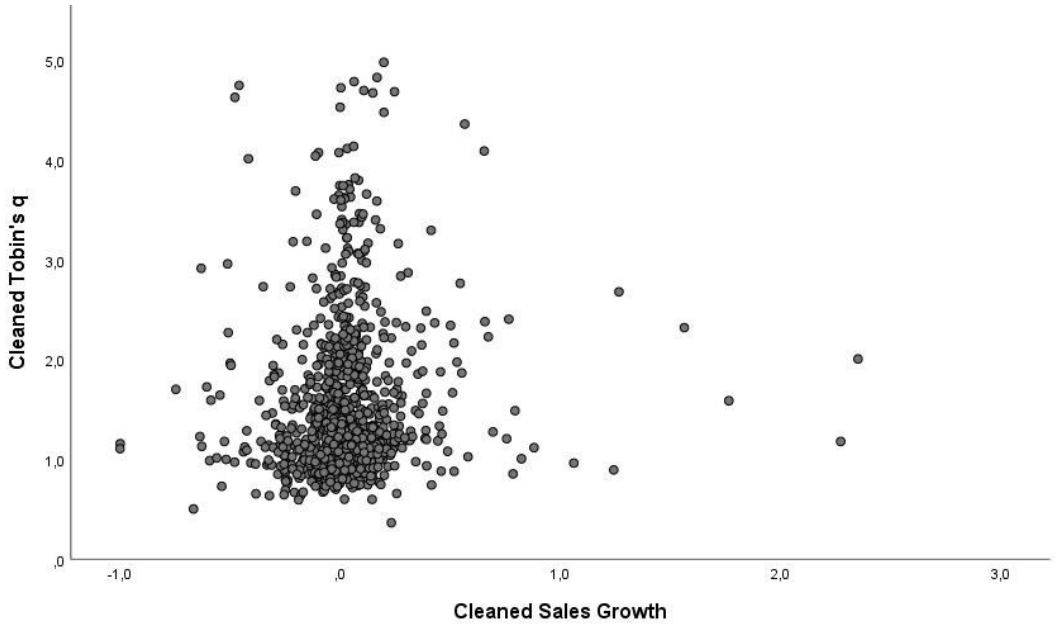
Appendix 4.1 Observation distribution, original ROA and EBITDA margin



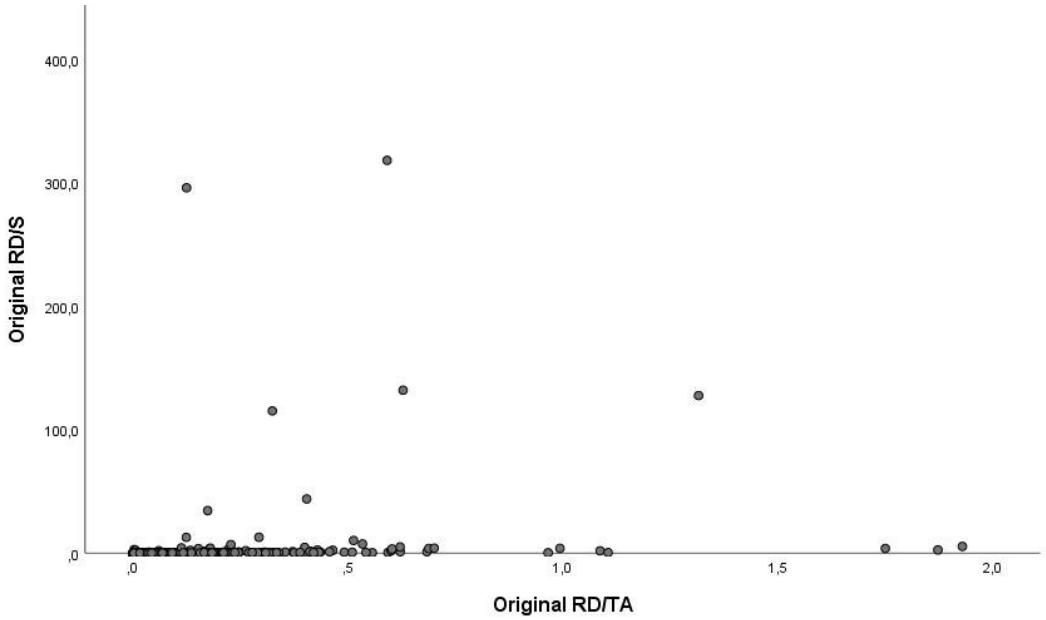
Appendix 4.2 Observation distribution, cleaned ROA and EBITDA margin



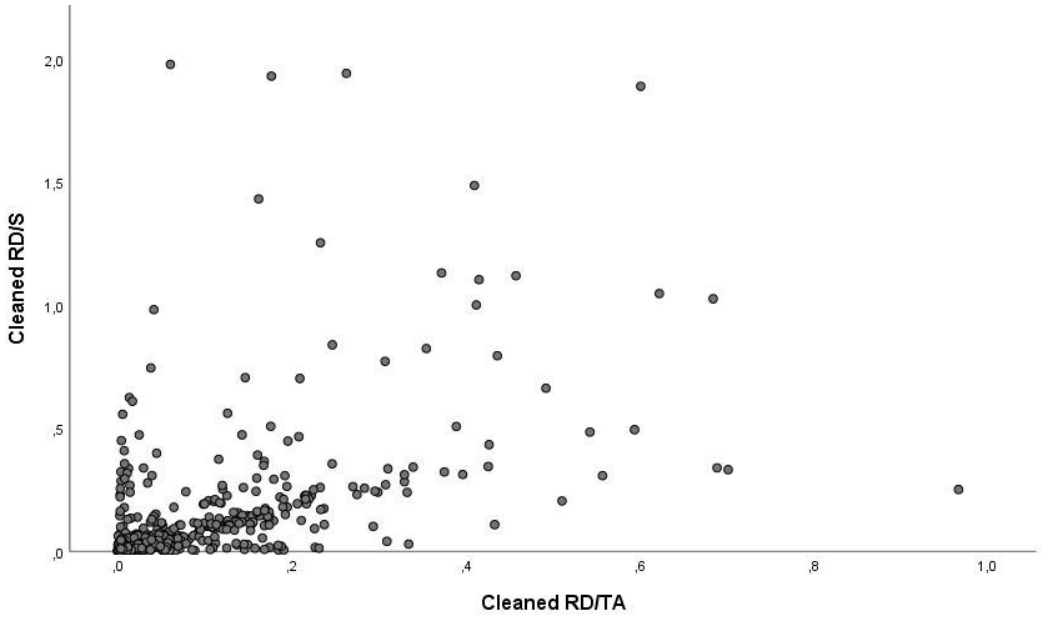
Appendix 4.3 Observation distribution, original Tobin's q and Sales Growth



Appendix 4.4 Observation distribution, cleaned Tobin's q and Sales Growth



Appendix 4.5 Observation distribution, original RD/S and RD/TA



Appendix 4.6 Observation distribution, cleaned RD/S and RD/TA

Appendix 5.

Descriptive statistics for the variables used in the regression models, time period 2009-2018.

							Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2009	90	0.148	0.194	0.012	0.883	2.264	4.771	0.711	0.000
FA Ratio 2009	90	0.230	0.181	0.000	0.715	0.658	-0.478	0.934	0.001
Firm Size 2009	90	5.742	2.298	0.054	11.060	0.001	-0.332	0.972	0.094
Debt Ratio 2009	89	0.529	0.168	0.090	1.239	0.361	3.071	0.974	0.124
ROA 2009	87	0.008	0.177	-0.849	0.684	-2.026	12.954	0.989	0.738
EBITDA margin 2009	84	0.089	0.163	-0.674	0.498	-1.820	8.317	0.941	0.002
Sales Growth 2009	88	-0.164	0.228	-0.705	0.530	0.150	0.400	0.980	0.272
Tobin's q 2009	85	1.559	0.757	0.692	4.698	1.866	4.031	0.794	0.000
RD/TA 2007	88	0.061	0.111	0.000	0.622	3.311	12.597	0.619	0.000
RD/S 2007	86	0.076	0.187	0.000	1.132	4.384	20.666	0.362	0.000

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage), and RD/S is research and development spending to total sales (as percentage).

Appendix 5.1 Descriptive statistics & Shapiro-Wilk test, table 2/11 – 2009

							Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2010	90	0.135	0.190	0.005	0.967	2.900	8.582	0.686	0.000
FA Ratio 2010	90	0.215	0.174	0.000	0.721	0.834	-0.043	0.926	0.000
Firm Size 2010	90	5.806	2.306	-0.472	11.204	-0.004	-0.251	0.972	0.073
Debt Ratio 2010	89	0.522	0.161	0.080	0.981	-0.170	0.505	0.988	0.624
ROA 2010	88	0.020	0.125	-0.426	0.255	-1.852	4.280	0.884	0.000
EBITDA margin 2010	84	0.112	0.124	-0.447	0.408	-0.528	4.343	0.936	0.000
Sales Growth 2010	87	0.102	0.318	-0.795	2.351	3.973	28.691	0.599	0.000
Tobin's q 2010	85	1.655	0.781	0.742	3.754	1.308	0.922	0.848	0.000
RD/TA 2008	88	0.072	0.126	0.000	0.601	2.700	7.455	0.646	0.000
RD/TA 2009	86	0.073	0.152	0.000	0.994	3.718	16.640	0.582	0.000

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 5.2 Descriptive statistics & Shapiro-Wilk test, table 3/11 – 2010

								Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2011	90	0.153	0.199	0.006	0.950	2.386	5.427	0.696	0.000
FA Ratio 2011	90	0.207	0.168	0.000	0.662	0.716	-0.501	0.927	0.000
Firm Size 2011	90	5.825	2.304	0.079	11.399	0.048	-0.406	0.983	0.347
Debt Ratio 2011	89	0.525	0.169	0.076	0.967	0.048	-0.406	0.986	0.543
ROA 2011	88	0.016	0.153	-0.579	0.537	-1.278	4.972	0.839	0.000
EBITDA margin 2011	84	0.093	0.191	-0.830	0.488	-2.214	9.325	0.795	0.000
Sales Growth 2011	86	0.018	0.174	-0.511	0.375	-0.837	0.934	0.959	0.012
Tobin's q 2011	86	1.378	0.620	0.637	3.086	1.277	0.929	0.860	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.3 Descriptive statistics & Shapiro-Wilk test, table 4/11 – 2011

								Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2012	90	0.139	0.184	0.006	0.935	2.723	7.592	0.723	0.000
FA Ratio 2012	90	0.207	0.169	0.000	0.670	0.743	-0.351	0.924	0.000
Firm Size 2012	90	5.789	2.325	1.113	11.465	0.084	-0.571	0.975	0.115
Debt Ratio 2012	90	0.536	0.171	0.109	1.102	0.043	1.223	0.976	0.145
ROA 2012	87	0.007	0.157	-0.754	0.253	-2.885	10.087	0.735	0.000
EBITDA margin 2012	82	0.106	0.132	-0.412	0.512	-0.459	3.868	0.927	0.000
Sales Growth 2012	90	0.047	0.332	-0.960	2.377	4.024	28.437	0.836	0.000
Tobin's q 2012	85	1.429	0.686	0.639	4.361	2.014	5.567	0.839	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.4 Descriptive statistics & Shapiro-Wilk test, table 5/11 – 2012

								Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2013	90	0.133	0.153	0.005	0.884	2.921	9.959	0.900	0.000
FA Ratio 2013	90	0.209	0.172	0.000	0.707	0.783	-0.205	0.928	0.000
Firm Size 2013	90	5.691	2.347	0.456	11.427	0.048	-0.615	0.982	0.367
Debt Ratio 2013	90	0.563	0.188	0.142	1.284	0.494	2.012	0.983	0.387
ROA 2013	88	-0.001	0.171	-0.855	0.385	-2.392	8.307	0.786	0.000
EBITDA margin 2013	84	0.078	0.220	-0.973	0.552	-2.606	10.432	0.833	0.000
Sales Growth 2013	90	-0.046	0.315	-0.999	1.764	1.703	12.384	0.880	0.000
Tobin's q 2013	81	1.599	0.850	0.503	4.629	1.777	3.290	0.818	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.5 Descriptive statistics & Shapiro-Wilk test, table 6/11 – 2013

							Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2014	90	0.126	0.153	0.004	0.794	3.085	10.310	0.753	0.000
FA Ratio 2014	90	0.233	0.177	0.002	0.643	0.765	-0.420	0.914	0.000
Firm Size 2014	90	5.753	2.271	0.646	11.433	0.107	-0.683	0.982	0.320
Debt Ratio 2014	90	0.541	0.193	0.110	1.198	0.152	1.407	0.971	0.062
ROA 2014	89	0.019	0.130	-0.428	0.489	-1.094	4.731	0.811	0.000
EBITDA margin 2014	88	0.090	0.238	-0.979	0.832	-1.935	8.522	0.681	0.000
Sales Growth 2014	87	0.023	0.179	-0.427	0.672	0.657	2.771	0.874	0.000
Tobin's q 2014	85	1.622	0.963	0.365	4.980	1.924	3.490	0.784	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.6 Descriptive statistics & Shapiro-Wilk test, table 7/11 – 2014

							Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2015	90	0.133	0.174	0.005	0.922	2.888	9.059	0.731	0.000
FA Ratio 2015	90	0.210	0.182	0.000	0.678	0.750	-0.477	0.917	0.000
Firm Size 2015	90	5.786	2.226	1.571	11.320	0.117	-0.689	0.985	0.471
Debt Ratio 2015	89	0.519	0.192	0.095	1.018	-0.205	0.377	0.975	0.118
ROA 2015	89	0.003	0.153	-0.566	0.353	-1.792	4.379	0.817	0.000
EBITDA margin 2015	88	0.090	0.192	-0.984	0.780	-1.906	12.853	0.717	0.000
Sales Growth 2015	89	0.070	0.347	-0.776	2.272	3.266	19.662	0.577	0.000
Tobin's q 2015	84	1.676	0.881	0.672	4.829	1.633	2.817	0.843	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.7 Descriptive statistics & Shapiro-Wilk test, table 8/11 – 2015

							Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2016	90	0.129	0.151	0.005	0.873	2.730	8.851	0.796	0.000
FA Ratio 2016	90	0.211	0.179	0.000	0.641	0.599	-0.898	0.910	0.000
Firm Size 2016	90	5.767	2.280	0.652	11.254	0.132	-0.631	0.983	0.360
Debt Ratio 2016	89	0.519	0.197	0.078	1.261	0.473	2.013	0.948	0.003
ROA 2016	88	0.039	0.195	-0.529	1.208	1.903	15.684	0.605	0.000
EBITDA margin 2016	88	0.090	0.181	-0.584	0.710	-0.641	6.890	0.843	0.000
Sales Growth 2016	89	-0.008	0.185	-0.631	0.880	1.036	7.088	0.838	0.000
Tobin's q 2016	82	1.698	0.789	0.595	4.750	1.504	2.446	0.858	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.8 Descriptive statistics & Shapiro-Wilk test, table 9/11 – 2016

								Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2017	89	0.133	0.157	0.003	0.869	2.832	9.070	0.739	0.000
FA Ratio 2017	89	0.207	0.176	0.000	0.675	0.655	-0.671	0.917	0.000
Firm Size 2017	89	5.747	2.265	1.501	11.156	0.190	-0.754	0.981	0.267
Debt Ratio 2017	89	0.510	0.194	0.087	1.191	0.462	1.944	0.957	0.008
ROA 2017	88	0.011	0.172	-0.733	0.360	-2.222	6.979	0.835	0.000
EBITDA margin 2017	87	0.130	0.167	-0.315	0.885	1.285	5.857	0.818	0.000
Sales Growth 2017	89	0.068	0.319	-0.596	2.020	3.803	20.471	0.711	0.000
Tobin's q 2017	83	1.785	0.806	0.809	4.530	1.326	1.456	0.875	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.9 Descriptive statistics & Shapiro-Wilk test, table 10/11 – 2017

								Shapiro-Wilk test	
Variables	Obs.	Mean	St. Dev	Min	Max	Skewness	Kurtosis	W	sig.
Cash Ratio 2018	89	0.127	0.151	0.004	0.978	3.009	11.812	0.763	0.000
FA Ratio 2018	89	0.201	0.166	0.000	0.580	0.547	-0.988	0.912	0.000
Firm Size 2018	89	5.763	2.246	1.596	11.169	0.229	-0.798	0.979	0.185
Debt Ratio 2018	89	0.504	0.203	0.048	1.228	0.169	1.121	0.965	0.022
ROA 2018	88	0.033	0.146	-0.859	0.425	-2.616	16.447	0.698	0.000
EBITDA margin 2018	87	0.120	0.157	-0.336	0.733	0.884	3.949	0.870	0.000
Sales Growth 2018	89	0.038	0.189	-0.787	0.823	0.180	6.844	0.884	0.000
Tobin's q 2018	86	1.654	0.841	0.656	4.674	1.418	1.710	0.848	0.000

Note: Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets.

Appendix 5.10 Descriptive statistics & Shapiro-Wilk test, table 11/11 – 2018

Appendix 6.

Pearson's r correlation matrix for the variables used in the regression models, time period 2009–2018.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2009	-.263*	1.000									
	(0.013)										
(3) FA Ratio 2009	0.108	-.461*	1.000								
	(0.314)	(0.000)									
(4) Firm Size 2009	0.312*	-.550*	0.491*	1.000							
	(0.003)	(0.000)	(0.000)								
(5) Debt Ratio 2009	-.030	-.283*	0.238*	0.095	1.000						
	(0.782)	(0.007)	(0.024)	(0.377)							
(6) ROA 2009	0.130	-.164	0.015	0.207	-.194	1.000					
	(0.232)	(0.128)	(0.891)	(0.055)	(0.072)						
(7) EBITDA margin 2009	0.184	-.382*	0.237*	0.416*	-.421*	0.778*	1.000				
	(0.095)	(0.000)	(0.030)	(0.000)	(0.000)	(0.000)					
(8) Sales Growth 2009	0.100	-.028	-.077	0.031	-.013	0.234*	0.292*	1.000			
	(0.355)	(0.797)	(0.475)	(0.777)	(0.906)	(0.031)	(0.007)				
(9) Tobin's q 2009	0.010	0.317*	-.257*	-.209	-.262*	0.234*	0.293*	0.322*	1.000		
	(0.926)	(0.003)	(0.017)	(0.055)	(0.016)	(0.032)	(0.008)	(0.003)			
(10) RD/TA 2007	-.123	0.718*	-.439*	-.532*	-.219*	-.129	-.223*	-.097	0.467*	1.000	
	(0.258)	(0.000)	(0.000)	(0.000)	(0.042)	(0.238)	(0.043)	(0.375)	(0.000)		
(11) RD/S 2007	-.219*	0.742*	-.362*	-.442*	-.287*	0.423*	-.328*	-.231*	0.246*	0.871*	1.000
	(0.044)	(0.000)	(0.001)	(0.000)	(0.008)	(0.000)	(0.003)	(0.034)	(0.027)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage), and RD/S is research and development spending to total sales (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.1 Pearson's r Correlations, table 2/11 – 2009

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2010	-.184	1.000									
	(0.084)										
(3) FA Ratio 2010	0.115	-.392*	1.000								
	(0.283)	(0.000)									
(4) Firm Size 2010	0.313*	-.439*	0.493*	1.000							
	(0.003)	(0.000)	(0.000)								
(5) Debt Ratio 2010	-.019	-.460*	0.243*	0.169	1.000						
	(0.861)	(0.000)	(0.022)	(0.114)							
(6) ROA 2010	0.254*	-.339*	0.222*	0.369*	-.068	1.000					
	(0.017)	(0.001)	(0.037)	(0.000)	(0.529)						
(7) EBITDA margin 2010	0.179	-.149	0.296*	0.498*	-.257*	0.580*	1.000				
	(0.103)	(0.173)	(0.006)	(0.000)	(0.018)	(0.000)					
(8) Sales Growth 2010	-.060	0.190	0.048	0.034	-.132	0.094	-.022	1.000			
	(0.579)	(0.075)	(0.658)	(0.749)	(0.220)	(0.385)	(0.842)				
(9) Tobin's q 2010	-.013	0.339*	-.340*	-.213*	-.295*	0.190	0.255*	-.023	1.000		
	(0.907)	(0.001)	(0.001)	(0.049)	(0.006)	(0.079)	(0.021)	(0.836)			
(10) RD/TA 2008	-.207	0.720*	-.455*	-.587*	-.384*	-.372*	-.441*	-.005	0.426*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.962)	(0.000)		
(11) RD/TA 2009	-.228*	0.659*	-.382*	-.531*	-.285*	0.412*	-.410*	-.108	0.477*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.312)	(0.027)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.2 Pearson's r Correlations, table 3/11 - 2010

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2011	-.230*	1.000									
	(0.030)										
(3) FA Ratio 2011	0.198	-.420*	1.000								
	(0.063)	(0.000)									
(4) Firm Size 2011	0.297*	-.459*	0.506*	1.000							
	(0.005)	(0.000)	(0.000)								
(5) Debt Ratio 2011	-.019	-.582*	0.271*	0.245*	1.000						
	(0.864)	(0.000)	(0.010)	(0.021)							
(6) ROA 2011	0.198	-.159	0.706	0.285*	-.082	1.000					
	(0.066)	(0.140)	(0.484)	(0.007)	(0.449)						
(7) EBITDA margin 2011	0.138	-.495*	0.271*	0.430*	0.079	0.299*	1.000				
	(0.213)	(0.000)	(0.013)	(0.000)	(0.478)	(0.006)					
(8) Sales Growth 2011	0.051	-.205	0.173	0.217*	0.273*	0.320*	0.273*	1.000			
	(0.643)	(0.058)	(0.110)	(0.044)	(0.011)	(0.003)	(0.013)				
(9) Tobin's q 2011	-.005	0.401*	-.298*	-.302*	-.307*	0.118	0.098	-.048	1.000		
	(0.965)	(0.000)	(0.005)	(0.005)	(0.004)	(0.282)	(0.386)	(0.662)			
(10) RD/TA 2008	-.207	0.654*	-.447*	-.575*	-.447*	-.349*	-.474*	-.406*	0.527*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)		
(11) RD/TA 2009	-.228*	0.613*	-.373*	-.527*	-.382*	-.389*	-.607*	-.362*	0.527*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.3 Pearson's r Correlations, table 4/11 – 2011

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2012	-.262*	1.000									
	(0.013)										
(3) FA Ratio 2012	0.148	-.363*	1.000								
	(0.165)	(0.000)									
(4) Firm Size 2012	0.292*	-.478*	0.510*	1.000							
	(0.005)	(0.000)	(0.000)								
(5) Debt Ratio 2012	-.004	-.459*	0.159	0.191	1.000						
	(0.971)	(0.000)	(0.134)	(0.071)							
(6) ROA 2012	0.332*	-.339*	0.070	0.339*	0.071	1.000					
	(0.002)	(0.001)	(0.520)	(0.001)	(0.512)						
(7) EBITDA margin 2012	0.021	-.205	0.319*	0.360*	-.290*	0.549*	1.000				
	(0.854)	(0.065)	(0.003)	(0.001)	(0.008)	(0.000)					
(8) Sales Growth 2012	-.229*	0.259*	-.128	-.172	-.067	0.270*	0.008	1.000			
	(0.031)	(0.014)	(0.229)	(0.105)	(0.531)	(0.011)	(0.942)				
(9) Tobin's q 2012	0.045	0.349*	-.324*	-.182	-.141	0.275*	0.034	0.346*	1.000		
	(0.684)	(0.001)	(0.002)	(0.096)	(0.199)	(0.011)	(0.762)	(0.001)			
(10) RD/TA 2008	-.207	0.811*	-.426*	-.570*	-.362*	-.456*	-.303*	0.284*	0.420*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.006)	(0.007)	(0.000)		
(11) RD/TA 2009	-.228*	0.686*	-.346*	-.528*	-.316*	-.529*	-.305*	0.243*	0.474*	0.848*	1.000
	(0.031)	(0.000)	(0.001)	(0.000)	(0.002)	(0.000)	(0.005)	(0.021)	(0.000)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.4 Pearson's r Correlations, table 5/11 - 2012

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2013	-.177	1.000									
	(0.097)										
(3) FA Ratio 2013	0.145	-.361*	1.000								
	(0.174)	(0.000)									
(4) Firm Size 2013	0.295*	-.453*	0.498*	1.000							
	(0.005)	(0.000)	(0.000)								
(5) Debt Ratio 2013	-.058	-.331*	0.056	0.048	1.000						
	(0.588)	(0.001)	(0.598)	(0.651)							
(6) ROA 2013	0.276*	-.460*	0.165	0.387*	0.040	1.000					
	(0.010)	(0.000)	(0.125)	(0.000)	(0.714)						
(7) EBITDA margin 2013	0.133	-.291*	0.254*	0.499*	-.057	0.617*	1.000				
	(0.229)	(0.007)	(0.020)	(0.000)	(0.609)	(0.000)					
(8) Sales Growth 2013	0.092	0.036	-.101	-.022	-.169	0.205	0.120	1.000			
	(0.391)	(0.737)	(0.341)	(0.834)	(0.112)	(0.055)	(0.275)				
(9) Tobin's q 2013	0.018	0.253*	-.323*	-.179	-.304*	0.197	0.146	0.174	1.000		
	(0.873)	(0.023)	(0.001)	(0.109)	(0.006)	(0.078)	(0.206)	(0.120)			
(10) RD/TA 2008	-.207	0.677*	-.431*	-.561*	-.213*	-.390*	-.561*	0.070	0.351*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.045)	(0.000)	(0.000)	(0.514)	(0.001)		
(11) RD/TA 2009	-.228*	0.715*	-.378*	-.498*	-.288*	0.457*	-.562*	0.035	0.343*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.006)	(0.000)	(0.000)	(0.742)	(0.002)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.5 Pearson's r Correlations, table 6/11 – 2013

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2014	-.221*	1.000									
	(0.037)										
(3) FA Ratio 2014	0.175	-.393*	1.000								
	(0.101)	(0.000)									
(4) Firm Size 2014	0.310*	-.431*	0.514*	1.000							
	(0.003)	(0.000)	(0.000)								
(5) Debt Ratio 2014	-.067	-.346*	0.120	0.081	1.000						
	(0.536)	(0.001)	(0.258)	(0.449)							
(6) ROA 2014	0.420*	-.359*	0.219*	0.437*	-.113	1.000					
	(0.000)	(0.001)	(0.039)	(0.000)	(0.290)						
(7) EBITDA margin 2014	0.094	-.334*	0.376*	0.513*	0.237*	0.561*	1.000				
	(0.384)	(0.001)	(0.000)	(0.000)	(0.026)	(0.000)					
(8) Sales Growth 2014	-.032	0.149	-.095	-.100	-.470*	0.136	-.169	1.000			
	(0.768)	(0.169)	(0.383)	(0.358)	(0.000)	(0.213)	(0.123)				
(9) Tobin's q 2014	-.064	0.548*	-.374*	-.262*	-.304*	-.069	-.192	0.176	1.000		
	(0.564)	(0.000)	(0.000)	(0.015)	(0.005)	(0.532)	(0.082)	(0.114)			
(10) RD/TA 2008	-.207	0.721*	-.450*	-.478*	-.422*	-.381*	-.544*	0.225*	0.477*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.036)	(0.000)		
(11) RD/TA 2009	-.228*	0.779*	-.396*	-.461*	-.335*	-.396*	-.529*	0.234*	0.603*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.029)	(0.000)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.6 Pearson's r Correlations, table 7/11 - 2014

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2015	-.282*	1.000									
	(0.007)										
(3) FA Ratio 2015	0.189	-.375*	1.000								
	(0.076)	(0.000)									
(4) Firm Size 2015	0.312*	-.339*	0.490*	1.000							
	(0.003)	(0.001)	(0.000)								
(5) Debt Ratio 2015	0.019	-.568*	0.286*	0.204	1.000						
	(0.859)	(0.000)	(0.007)	(0.056)							
(6) ROA 2015	0.311*	-.321*	0.183	0.417*	0.053	1.000					
	(0.003)	(0.002)	(0.085)	(0.000)	(0.624)						
(7) EBITDA margin 2015	0.248*	-.258*	0.320*	0.494*	0.253*	0.574*	1.000				
	(0.020)	(0.015)	(0.002)	(0.000)	(0.018)	(0.000)					
(8) Sales Growth 2015	-.011	-.040	-.012	-.062	0.133	-.097	0.130	1.000			
	(0.921)	(0.709)	(0.910)	(0.563)	(0.218)	(0.369)	(0.229)				
(9) Tobin's q 2015	0.056	0.393*	-.299*	-.163	-.260*	0.054	-.020	0.083	1.000		
	(0.615)	(0.000)	(0.006)	(0.140)	(0.017)	(0.630)	(0.857)	(0.457)			
(10) RD/TA 2008	-.207	0.696*	-.449*	-.442*	-.533*	-.393*	-.505*	-.027	0.429*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.803)	(0.000)		
(11) RD/TA 2009	-.228*	0.753*	-.397*	-.440*	-.469*	-.447*	-.457*	0.091	0.408*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.396)	(0.027)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.7 Pearson's r Correlations, table 8/11 – 2015

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2016	-.268*	1.000									
	(0.011)										
(3) FA Ratio 2016	0.193	-.420*	1.000								
	(0.070)	(0.000)									
(4) Firm Size 2016	0.338*	-.403*	0.491*	1.000							
	(0.001)	(0.000)	(0.000)								
(5) Debt Ratio 2016	-.019	-.456*	0.165	0.098	1.000						
	(0.863)	(0.000)	(0.121)	(0.359)							
(6) ROA 2016	0.110	-.199	0.093	0.162	-.046	1.000					
	(0.309)	(0.063)	(0.387)	(0.130)	(0.669)						
(7) EBITDA margin 2016	0.179	-.278*	0.364*	0.480*	0.042	0.521*	1.000				
	(0.097)	(0.009)	(0.000)	(0.000)	(0.699)	(0.000)					
(8) Sales Growth 2016	0.087	0.130	-.192	-.012	-.208	0.194	0.050	1.000			
	(0.419)	(0.224)	(0.071)	(0.914)	(0.052)	(0.072)	(0.641)				
(9) Tobin's q 2016	-.128	0.346*	-.316*	-.228*	0.058	-.234*	-.274*	-.142	1.000		
	(0.255)	(0.001)	(0.004)	(0.040)	(0.605)	(0.036)	(0.013)	(0.203)			
(10) RD/TA 2008	-.207	0.697*	-.455*	-.439*	-.427*	-.296*	-.443*	0.293*	0.286*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)	(0.000)	(0.006)	(0.010)		
(11) RD/TA 2009	-.228*	0.730*	-.404*	-.443*	-.322*	-.351*	-.455*	0.232*	0.354*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.007)	(0.000)	(0.000)	(0.028)	(0.001)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.8 Pearson's r Correlations, table 9/11 - 2016

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2017	-.211*	1.000									
	(0.048)										
(3) FA Ratio 2017	0.159	-.342*	1.000								
	(0.136)	(0.001)									
(4) Firm Size 2017	0.349*	-.412*	0.498*	1.000							
	(0.001)	(0.000)	(0.000)								
(5) Debt Ratio 2017	0.024	-.432*	0.207	0.146	1.000						
	(0.820)	(0.000)	(0.051)	(0.173)							
(6) ROA 2017	0.250*	-.493*	0.054	0.250*	-.141	1.000					
	(0.019)	(0.000)	(0.618)	(0.019)	(0.190)						
(7) EBITDA margin 2017	0.022	-.152	0.268*	0.264*	-.062	0.506*	1.000				
	(0.842)	(0.159)	(0.012)	(0.013)	(0.566)	(0.000)					
(8) Sales Growth 2017	0.012	-.028	-.040	0.003	-.057	0.306*	0.147	1.000			
	(0.908)	(0.798)	(0.707)	(0.981)	(0.598)	(0.004)	(0.176)				
(9) Tobin's q 2017	0.036	0.300*	-.251*	-.073	-.191	0.301*	0.164	0.124	1.000		
	(0.747)	(0.006)	(0.022)	(0.511)	(0.084)	(0.006)	(0.138)	(0.264)			
(10) RD/TA 2008	-.207	0.559*	-.439*	-.437*	-.355*	-.394*	-.353*	0.157	0.318*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.001)	(0.145)	(0.004)		
(11) RD/TA 2009	-.228*	0.642*	-.386*	-.444*	-.305*	-.460*	-.311*	0.097	0.386*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.004)	(0.000)	(0.003)	(0.368)	(0.000)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.9 Pearson's r Correlations, table 10/11 – 2017

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(1) Firm Age	1.000										
(2) Cash Ratio 2018	-.176	1.000									
	(0.100)										
(3) FA Ratio 2018	0.190	-.375*	1.000								
	(0.074)	(0.000)									
(4) Firm Size 2018	0.350*	-.388*	0.486*	1.000							
	(0.001)	(0.000)	(0.000)								
(5) Debt Ratio 2018	-.016	-.448*	0.261*	0.152	1.000						
	(0.882)	(0.000)	(0.013)	(0.154)							
(6) ROA 2018	0.214*	0.019	0.005	0.181	-.213*	1.000					
	(0.045)	(0.860)	(0.963)	(0.092)	(0.046)						
(7) EBITDA margin 2018	0.024	-.074	0.289*	0.398*	-.057	0.515*	1.000				
	(0.824)	(0.497)	(0.007)	(0.000)	(0.599)	(0.000)					
(8) Sales Growth 2018	0.053	-.154	0.016	0.106	-.024	0.175	0.073	1.000			
	(0.621)	(0.150)	(0.879)	(0.321)	(0.821)	(0.103)	(0.503)				
(9) Tobin's q 2018	-.037	0.369*	-.232*	-.121	-.260*	0.101	0.093	0.105	1.000		
	(0.734)	(0.000)	(0.031)	(0.266)	(0.016)	(0.353)	(0.395)	(0.335)			
(10) RD/TA 2008	-.207	0.520*	-.426*	-.444*	-.338*	-.180	-.285*	0.020	0.451*	1.000	
	(0.053)	(0.000)	(0.000)	(0.000)	(0.001)	(0.095)	(0.008)	(0.855)	(0.000)		
(11) RD/TA 2009	-.228*	0.626*	-.382*	-.430*	-.334*	-.199	-.220*	-.039	0.381*	0.848*	1.000
	(0.031)	(0.000)	(0.000)	(0.000)	(0.001)	(0.064)	(0.040)	(0.719)	(0.000)	(0.000)	

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage). Exact significance levels are presented in parentheses. * Shows significance on a .05 level.

Appendix 6.10 Pearson's r Correlations, table 11/11 - 2018

Appendix 7.

Multicollinearity examined through the variance inflation factor (VIF) test separately for each regression.

R&D activities and recessionary performance

Dependent:	*ROA 2008*		*ROA 2009*		*Sales Growth 2008*		*Sales Growth 2009*		*EBITDA margin 2008*		*EBITDA margin 2009*		*Tobin's q 2008*		*Tobin's q 2009*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.641	1.560	0.659	1.518	0.618	1.617	0.657	1.522	0.659	1.517	0.638	1.568	0.619	1.616	0.649	1.542
Cash Ratio 2008	0.345	2.898	0.374	2.672	0.424	2.361	0.390	2.565	0.447	2.236	0.536	1.867	0.343	2.917	0.356	2.809
FA Ratio 2008	0.436	2.291	0.450	2.223	0.410	2.439	0.455	2.198	0.447	2.237	0.404	2.473	0.434	2.305	0.438	2.283
Firm Size 2008	0.410	2.442	0.465	2.149	0.433	2.308	0.447	2.239	0.446	2.240	0.435	2.299	0.393	2.541	0.431	2.414
Debt Ratio 2008	0.430	2.328	0.621	1.610	0.675	1.482	0.726	1.377	0.473	2.113	0.750	1.334	0.429	2.333	0.591	1.693
RD/TA 2007	0.419	2.386	0.411	2.434	0.383	2.611	0.378	2.645	0.397	2.517	0.436	2.291	0.419	2.386	0.414	2.414
Country Dummy, FIN	0.744	1.344	0.721	1.388	0.772	1.295	0.705	1.418	0.778	1.286	0.771	1.297	0.765	1.307	0.729	1.372
Industry Dummy, 0500	0.298	3.355	0.295	3.388	0.312	3.206	0.299	3.350	0.298	3.353	0.314	3.189	0.233	4.300	0.235	4.250
Industry Dummy, 1300	0.588	1.700	0.605	1.654	0.597	1.675	0.743	1.346	0.728	1.374	0.605	1.653	0.505	1.979	0.509	1.963
Industry Dummy, 1700	0.317	3.154	0.317	3.156	0.318	3.147	0.318	3.148	0.318	3.145	0.318	3.144	0.223	4.482	0.224	4.457
Industry Dummy, 2300	0.307	3.258	0.306	3.269	0.324	3.088	0.314	3.187	0.306	3.270	0.309	3.231	0.274	3.644	0.267	3.744
Industry Dummy, 2700	0.126	7.933	0.137	7.295	0.143	7.009	0.146	6.847	0.131	7.640	0.146	6.834	0.093	10.699	0.096	10.439
Industry Dummy, 3300	0.568	1.761	0.589	1.699	0.590	1.694	0.596	1.678	0.568	1.762	0.596	1.678	0.470	2.130	0.475	2.106
Industry Dummy, 3500	0.338	2.962	0.340	2.942	0.293	3.410	0.300	3.331	0.338	2.959	0.300	3.336	0.250	3.993	0.250	4.000
Industry Dummy, 3700	0.324	3.085	0.348	2.874	0.343	2.917	0.353	2.835	0.323	3.096	0.351	2.850	0.259	3.856	0.266	3.759
Industry Dummy, 4500	0.311	3.219	0.366	2.735	0.300	3.335	0.295	3.388	0.330	3.034	0.433	2.312	0.235	4.257	0.235	4.257
Industry Dummy, 5500	0.453	2.206	0.475	2.107	0.474	2.109	0.476	2.101	0.453	2.207	0.474	2.110	0.363	2.752	0.368	2.716
Industry Dummy, 9500	0.139	7.213	0.139	7.186	0.145	6.873	0.134	7.443	0.129	7.725	0.130	7.663	0.101	9.924	0.100	9.979

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.1 VIF RD/TA 2007

Dependent:	*ROA 2008*		*ROA 2009*		*Sales Growth 2008*		*Sales Growth 2009*		*EBITDA margin 2008*		*EBITDA margin 2009*		*Tobin's q 2008*		*Tobin's q 2009*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.670	1.492	0.685	1.461	0.642	1.557	0.674	1.485	0.684	1.462	0.659	1.517	0.649	1.541	0.675	1.482
Cash Ratio 2008	0.375	2.668	0.430	2.898	0.379	2.642	0.362	2.766	0.446	2.242	0.557	1.797	0.375	2.665	0.393	2.543
FA Ratio 2008	0.446	2.242	0.464	2.155	0.412	2.428	0.462	2.165	0.452	2.211	0.410	2.440	0.443	2.256	0.451	2.217
Firm Size 2008	0.432	2.315	0.483	2.071	0.445	2.246	0.451	2.216	0.453	2.206	0.441	2.268	0.413	2.422	0.445	2.246
Debt Ratio 2008	0.461	2.170	0.644	1.553	0.700	1.429	0.749	1.336	0.495	2.020	0.753	1.327	0.462	2.163	0.617	1.621
RD/S 2007	0.353	2.833	0.407	2.458	0.334	2.996	0.334	2.998	0.440	2.274	0.448	2.234	0.352	2.845	0.345	2.901
Country Dummy, FIN	0.767	1.304	0.757	1.321	0.767	1.303	0.719	1.391	0.784	1.275	0.788	1.270	0.788	1.269	0.766	1.305
Industry Dummy, 0500	0.298	3.361	0.296	3.380	0.314	3.186	0.299	3.350	0.297	3.363	0.314	3.181	0.233	4.292	0.236	4.238
Industry Dummy, 1300	0.588	1.700	0.605	1.654	0.597	1.675	0.742	1.348	0.727	1.376	0.605	1.653	0.506	1.977	0.510	1.961
Industry Dummy, 1700	0.317	3.153	0.317	3.153	0.317	3.150	0.318	3.147	0.318	3.145	0.318	3.143	0.224	4.473	0.225	4.450
Industry Dummy, 2300	0.306	3.270	0.304	3.289	0.325	3.081	0.313	3.191	0.306	3.269	0.308	3.248	0.274	3.652	0.266	3.754
Industry Dummy, 2700	0.131	7.653	0.142	7.028	0.143	7.010	0.147	6.822	0.132	7.599	0.146	6.831	0.097	10.296	0.100	10.032
Industry Dummy, 3300	0.568	1.760	0.589	1.698	0.590	1.694	0.596	1.677	0.568	1.760	0.596	1.678	0.470	2.126	0.476	2.102
Industry Dummy, 3500	0.338	2.959	0.340	2.940	0.293	3.409	0.301	3.325	0.338	2.956	0.300	3.337	0.251	3.988	0.250	3.994
Industry Dummy, 3700	0.323	3.094	0.347	2.882	0.345	2.900	0.353	2.833	0.323	3.098	0.349	2.864	0.259	3.864	0.266	3.766
Industry Dummy, 4500	0.271	3.693	0.332	3.010	0.284	3.518	0.279	3.580	0.329	3.042	0.441	2.266	0.213	4.702	0.212	4.717
Industry Dummy, 5500	0.453	2.206	0.475	2.106	0.476	2.101	0.476	2.100	0.453	2.209	0.473	2.116	0.363	2.752	0.368	2.714
Industry Dummy, 9500	0.145	6.917	0.146	6.856	0.151	6.618	0.150	6.685	0.145	6.917	0.140	7.135	0.107	9.389	0.106	9.392

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/S is research and development spending to total sales (as percentage).

Appendix 7.2 VIF RD/S 2007

Dependent:	ROA 2010		Sales Growth 2010		EBITDA margin 2010		Tobin's q 2010	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.685	1.461	0.670	1.493	0.681	1.469	0.661	1.512
Cash Ratio 2010	0.360	2.777	0.362	2.765	0.608	1.645	0.357	2.805
FA Ratio 2010	0.474	2.111	0.482	2.073	0.425	2.352	0.454	2.204
Firm Size 2010	0.452	2.212	0.431	2.320	0.483	2.072	0.430	2.324
Debt Ratio 2010	0.595	1.679	0.618	1.617	0.681	1.468	0.563	1.777
RD/TA 2009	0.454	2.205	0.420	2.384	0.533	1.877	0.449	2.225
Country Dummy, FIN	0.701	1.426	0.702	1.425	0.789	1.268	0.716	1.397
Industry Dummy, 0500	0.290	3.451	0.290	3.445	0.304	3.285	0.236	4.244
Industry Dummy, 1300	0.609	1.641	0.609	1.641	0.609	1.641	0.508	1.969
Industry Dummy, 1700	0.315	3.178	0.315	3.178	0.315	3.171	0.225	4.453
Industry Dummy, 2300	0.308	3.242	0.308	3.242	0.305	3.275	0.236	4.234
Industry Dummy, 2700	0.139	7.191	0.143	6.972	0.144	6.933	0.096	10.469
Industry Dummy, 3300	0.590	1.695	0.591	1.692	0.587	1.705	0.475	2.103
Industry Dummy, 3500	0.343	2.919	0.342	2.920	0.343	2.914	0.251	3.979
Industry Dummy, 3700	0.354	2.828	0.354	2.828	0.353	2.836	0.267	3.740
Industry Dummy, 4500	0.260	3.845	0.259	3.857	0.359	2.783	0.193	5.187
Industry Dummy, 5500	0.405	2.469	0.405	2.470	0.401	2.492	0.306	3.269
Industry Dummy, 9500	0.145	6.913	0.137	7.280	0.134	7.482	0.101	9.900

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.3 VIF RD/TA 2009, 2010

Dependent:	ROA 2010		Sales Growth 2010		EBITDA margin 2010		Tobin's q 2010	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.652	1.533	0.650	1.540	0.670	1.493	0.626	1.597
Cash Ratio 2010	0.280	3.570	0.290	3.444	0.515	1.941	0.280	3.575
FA Ratio 2010	0.411	2.433	0.418	2.392	0.426	2.348	0.364	2.747
Firm Size 2010	0.440	2.270	0.421	2.374	0.483	2.071	0.409	2.446
Debt Ratio 2010	0.612	1.633	0.630	1.586	0.682	1.466	0.576	1.736
RD/TA 2008	0.299	3.340	0.280	3.568	0.376	2.660	0.299	3.348
Country Dummy, FIN	0.722	1.386	0.723	1.383	0.786	1.272	0.736	1.358
Industry Dummy, 0500	0.305	3.276	0.306	3.264	0.304	3.287	0.245	4.086
Industry Dummy, 1300	0.609	1.642	0.609	1.643	0.609	1.642	0.507	1.971
Industry Dummy, 1700	0.315	3.177	0.315	3.178	0.315	3.171	0.224	4.464
Industry Dummy, 2300	0.306	3.270	0.306	3.270	0.305	3.275	0.233	4.286
Industry Dummy, 2700	0.139	7.202	0.143	6.981	0.144	6.938	0.095	10.499
Industry Dummy, 3300	0.590	1.694	0.591	1.692	0.587	1.703	0.476	2.103
Industry Dummy, 3500	0.342	2.921	0.342	2.921	0.343	2.914	0.251	3.976
Industry Dummy, 3700	0.352	2.838	0.352	2.838	0.353	2.836	0.267	3.752
Industry Dummy, 4500	0.265	3.778	0.260	3.841	0.342	2.920	0.194	5.143
Industry Dummy, 5500	0.401	2.494	0.401	2.493	0.402	2.491	0.304	3.293
Industry Dummy, 9500	0.136	7.353	0.127	7.900	0.129	7.751	0.096	10.456

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.4 VIF RD/TA 2008, 2010

Dependent:	ROA 2011		Sales Growth 2011		EBITDA margin 2011		Tobin's q 2011	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.656	1.524	0.664	1.506	0.650	1.539	0.623	1.606
Cash Ratio 2011	0.349	2.862	0.378	2.644	0.431	2.320	0.352	2.843
FA Ratio 20111	0.454	2.201	0.446	2.244	0.438	2.284	0.442	2.265
Firm Size 2011	0.449	2.227	0.445	2.245	0.470	2.129	0.438	2.283
Debt Ratio 2011	0.501	1.995	0.533	1.876	0.573	1.746	0.482	2.077
RD/TA 2009	0.508	1.969	0.482	2.077	0.585	1.709	0.513	1.948
Country Dummy, FIN	0.724	1.381	0.754	1.326	0.792	1.262	0.739	1.353
Industry Dummy, 0500	0.301	3.324	0.331	3.022	0.324	3.090	0.238	4.208
Industry Dummy, 1300	0.609	1.643	0.609	1.642	0.609	1.642	0.506	1.975
Industry Dummy, 1700	0.315	3.170	0.316	3.162	0.316	3.166	0.221	4.519
Industry Dummy, 2300	0.303	3.302	0.300	3.333	0.301	3.327	0.240	4.174
Industry Dummy, 2700	0.136	7.328	0.140	7.132	0.142	7.047	0.097	10.308
Industry Dummy, 3300	0.585	1.709	0.582	1.717	0.583	1.715	0.476	2.101
Industry Dummy, 3500	0.343	2.919	0.343	2.916	0.343	2.914	0.251	3.983
Industry Dummy, 3700	0.354	2.825	0.352	2.843	0.353	2.831	0.271	3.686
Industry Dummy, 4500	0.246	4.064	0.250	3.993	0.269	3.718	0.183	5.468
Industry Dummy, 5500	0.401	2.493	0.396	2.523	0.399	2.505	0.309	3.241
Industry Dummy, 9500	0.145	6.916	0.141	7.104	0.150	6.688	0.108	9.268

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.5 VIF RD/TA 2009, 2011

Dependent:	ROA 2011		Sales Growth 2011		EBITDA margin 2011		Tobin's q 2011	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.625	1.599	0.641	1.561	0.641	1.560	0.590	1.695
Cash Ratio 2011	0.298	3.358	0.361	2.773	0.415	2.408	0.300	3.328
FA Ratio 20111	0.421	2.376	0.395	2.529	0.438	2.282	0.390	2.561
Firm Size 2011	0.441	2.269	0.433	2.309	0.474	2.109	0.421	2.374
Debt Ratio 2011	0.505	1.981	0.537	1.863	0.578	1.730	0.484	2.067
RD/TA 2008	0.379	2.635	0.339	2.953	0.397	2.520	0.384	2.607
Country Dummy, FIN	0.750	1.333	0.777	1.287	0.802	1.248	0.760	1.316
Industry Dummy, 0500	0.324	3.084	0.353	2.837	0.324	3.090	0.255	3.923
Industry Dummy, 1300	0.609	1.643	0.609	1.642	0.609	1.642	0.506	1.975
Industry Dummy, 1700	0.315	3.173	0.316	3.166	0.316	3.166	0.220	4.549
Industry Dummy, 2300	0.300	3.332	0.295	3.388	0.300	3.328	0.238	4.205
Industry Dummy, 2700	0.136	7.342	0.139	7.171	0.142	7.049	0.097	10.322
Industry Dummy, 3300	0.585	1.709	0.582	1.718	0.583	1.715	0.476	2.101
Industry Dummy, 3500	0.343	2.919	0.343	2.918	0.343	2.914	0.251	3.982
Industry Dummy, 3700	0.353	2.830	0.350	2.855	0.354	2.828	0.271	3.687
Industry Dummy, 4500	0.253	3.956	0.237	4.222	0.260	3.851	0.187	5.360
Industry Dummy, 5500	0.399	2.508	0.392	2.552	0.399	2.507	0.308	3.251
Industry Dummy, 9500	0.138	7.223	0.128	7.795	0.139	7.195	0.104	9.626

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.6 VIF RD/TA 2008, 2011

Dependent:	*ROA 2012*		*Sales Growth 2012*		*EBITDA margin 2012*		*Tobin's q 2012*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.650	1.538	0.674	1.485	0.660	1.516	0.623	1.605
Cash Ratio 2012	0.427	2.343	0.367	2.725	0.421	2.376	0.243	4.114
FA Ratio 2012	0.420	2.383	0.412	2.426	0.404	2.474	0.380	2.632
Firm Size 2012	0.452	2.214	0.425	2.353	0.525	1.905	0.451	2.218
Debt Ratio 2012	0.551	1.815	0.579	1.726	0.650	1.539	0.577	1.733
RD/TA 2009	0.484	2.065	0.412	2.425	0.479	2.090	0.278	3.600
Country Dummy, FIN	0.726	1.378	0.690	1.450	0.779	1.285	0.740	1.351
Industry Dummy, 0500	0.292	3.423	0.292	3.424	0.309	3.232	0.225	4.443
Industry Dummy, 1300	0.606	1.649	0.607	1.649	0.606	1.651	0.503	1.988
Industry Dummy, 1700	0.314	3.189	0.313	3.196	0.311	3.212	0.219	4.575
Industry Dummy, 2300	0.311	3.216	0.313	3.196	0.308	3.242	0.242	4.127
Industry Dummy, 2700	0.144	6.949	0.139	7.219	0.142	7.031	0.100	9.962
Industry Dummy, 3300	0.596	1.678	0.597	1.676	0.580	1.723	0.477	2.096
Industry Dummy, 3500	0.307	3.254	0.309	3.235	0.346	2.889	0.220	4.540
Industry Dummy, 3700	0.357	2.803	0.358	2.792	0.352	2.844	0.271	3.689
Industry Dummy, 4500	0.261	3.831	0.271	3.693	0.368	2.715	0.228	4.379
Industry Dummy, 5500	0.405	2.471	0.405	2.472	0.401	2.495	0.310	3.226
Industry Dummy, 9500	0.156	6.411	0.142	7.036	0.137	7.289	0.106	9.471

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.7 VIF RD/TA 2009, 2012

Dependent:	*ROA 2012*		*Sales Growth 2012*		*EBITDA margin 2012*		*Tobin's q 2012*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.636	1.572	0.651	1.537	0.653	1.530	0.609	1.641
Cash Ratio 2012	0.332	3.012	0.250	4.007	0.351	2.850	0.283	3.539
FA Ratio 2012	0.399	2.506	0.394	2.540	0.405	2.469	0.346	2.893
Firm Size 2012	0.450	2.220	0.415	2.409	0.524	1.910	0.437	2.288
Debt Ratio 2012	0.550	1.819	0.582	1.717	0.674	1.485	0.594	1.684
RD/TA 2008	0.334	2.996	0.254	3.930	0.343	2.912	0.298	3.356
Country Dummy, FIN	0.752	1.330	0.714	1.401	0.768	1.302	0.766	1.306
Industry Dummy, 0500	0.313	3.194	0.313	3.193	0.309	3.233	0.240	4.163
Industry Dummy, 1300	0.606	1.650	0.606	1.650	0.605	1.653	0.503	1.988
Industry Dummy, 1700	0.313	3.194	0.312	3.201	0.311	3.218	0.217	4.599
Industry Dummy, 2300	0.309	3.236	0.311	3.216	0.309	3.239	0.241	4.141
Industry Dummy, 2700	0.144	6.951	0.139	7.216	0.142	7.035	0.101	9.892
Industry Dummy, 3300	0.595	1.681	0.595	1.681	0.580	1.724	0.477	2.095
Industry Dummy, 3500	0.306	3.271	0.309	3.236	0.346	2.889	0.219	4.557
Industry Dummy, 3700	0.355	2.815	0.356	2.812	0.350	2.855	0.271	3.684
Industry Dummy, 4500	0.267	3.744	0.279	3.584	0.364	2.748	0.228	4.383
Industry Dummy, 5500	0.403	2.484	0.403	2.484	0.400	2.497	0.310	3.228
Industry Dummy, 9500	0.153	6.518	0.141	7.111	0.137	7.320	0.105	9.560

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.8 VIF RD/TA 2008, 2012

Dependent:	*ROA 2013*		*Sales Growth 2013*		*EBITDA margin 2013*		*Tobin's q 2013*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.680	1.470	0.700	1.428	0.668	1.497	0.670	1.493
Cash Ratio 2013	0.372	2.686	0.379	2.636	0.432	2.314	0.491	2.038
FA Ratio 2013	0.437	2.288	0.433	2.311	0.447	2.236	0.402	2.488
Firm Size 2013	0.444	2.252	0.442	2.261	0.485	2.063	0.484	2.068
Debt Ratio 2013	0.671	1.491	0.710	1.409	0.718	1.393	0.615	1.625
RD/TA 2009	0.373	2.678	0.368	2.716	0.408	2.448	0.475	2.104
Country Dummy, FIN	0.738	1.354	0.731	1.368	0.776	1.288	0.775	1.290
Industry Dummy, 0500	0.291	3.433	0.291	3.436	0.334	2.994	0.224	4.456
Industry Dummy, 1300	0.603	1.657	0.604	1.656	0.604	1.655	0.496	2.016
Industry Dummy, 1700	0.317	3.159	0.316	3.162	0.317	3.157	0.221	4.523
Industry Dummy, 2300	0.316	3.165	0.319	3.135	0.315	3.176	0.242	4.126
Industry Dummy, 2700	0.144	6.958	0.139	7.204	0.144	6.940	0.101	9.872
Industry Dummy, 3300	0.593	1.685	0.594	1.683	0.586	1.705	0.475	2.103
Industry Dummy, 3500	0.302	3.316	0.302	3.316	0.302	3.311	0.215	4.654
Industry Dummy, 3700	0.357	2.798	0.359	2.783	0.358	2.796	0.271	3.686
Industry Dummy, 4500	0.289	3.459	0.275	3.637	0.344	2.907	0.258	3.878
Industry Dummy, 5500	0.408	2.451	0.409	2.444	0.408	2.451	0.312	3.202
Industry Dummy, 9500	0.139	7.199	0.141	7.102	0.145	6.896	0.124	8.097

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.9 VIF RD/TA 2009, 2013

Dependent:	*ROA 2013*		*Sales Growth 2013*		*EBITDA margin 2013*		*Tobin's q 2013*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.668	1.498	0.692	1.445	0.670	1.493	0.654	1.528
Cash Ratio 2013	0.394	2.541	0.414	2.418	0.547	1.829	0.544	1.839
FA Ratio 2013	0.413	2.419	0.408	2.449	0.438	2.282	0.358	2.792
Firm Size 2013	0.437	2.287	0.414	2.414	0.468	2.138	0.461	2.171
Debt Ratio 2013	0.639	1.565	0.698	1.433	0.719	1.391	0.575	1.741
RD/TA 2008	0.388	2.574	0.379	2.638	0.465	2.151	0.529	1.890
Country Dummy, FIN	0.768	1.302	0.740	1.351	0.778	1.285	0.798	1.253
Industry Dummy, 0500	0.312	3.388	0.313	3.192	0.337	2.971	0.234	4.265
Industry Dummy, 1300	0.603	1.657	0.604	1.655	0.605	1.654	0.494	2.022
Industry Dummy, 1700	0.316	3.160	0.316	3.160	0.317	3.153	0.220	4.554
Industry Dummy, 2300	0.314	3.185	0.316	3.162	0.314	3.181	0.241	4.149
Industry Dummy, 2700	0.144	6.947	0.139	7.205	0.145	6.911	0.102	9.834
Industry Dummy, 3300	0.594	1.685	0.595	1.682	0.589	1.697	0.476	2.102
Industry Dummy, 3500	0.301	3.327	0.301	3.318	0.300	3.337	0.215	4.658
Industry Dummy, 3700	0.357	2.803	0.358	2.792	0.357	2.799	0.271	3.688
Industry Dummy, 4500	0.290	3.444	0.280	3.572	0.344	2.908	0.256	3.899
Industry Dummy, 5500	0.407	2.459	0.407	2.456	0.407	2.458	0.312	3.208
Industry Dummy, 9500	0.136	7.349	0.140	7.136	0.144	6.925	0.122	8.183

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.10 VIF RD/TA 2008, 2013

Dependent:	ROA 2014		Sales Growth 2014		EBITDA margin 2014		Tobin's q 2014	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.680	1.470	0.639	1.565	0.683	1.465	0.655	1.527
Cash Ratio 2014	0.305	3.276	0.289	3.460	0.313	3.194	0.354	2.824
FA Ratio 2014	0.397	2.519	0.421	2.376	0.394	2.537	0.341	2.930
Firm Size 2014	0.475	2.106	0.461	2.168	0.480	2.084	0.454	2.201
Debt Ratio 2014	0.635	1.575	0.676	1.479	0.652	1.535	0.678	1.474
RD/TA 2009	0.341	2.929	0.332	3.016	0.380	2.633	0.353	2.832
Country Dummy, FIN	0.744	1.343	0.727	1.375	0.767	1.305	0.765	1.308
Industry Dummy, 0500	0.283	3.538	0.331	3.017	0.280	3.568	0.217	4.617
Industry Dummy, 1300	0.600	1.667	0.600	1.667	0.600	1.668	0.496	2.016
Industry Dummy, 1700	0.310	3.221	0.311	3.220	0.309	3.237	0.217	4.606
Industry Dummy, 2300	0.317	3.157	0.317	3.153	0.317	3.155	0.240	4.161
Industry Dummy, 2700	0.139	7.198	0.145	6.893	0.139	7.203	0.096	10.400
Industry Dummy, 3300	0.582	1.718	0.582	1.717	0.575	1.738	0.468	2.137
Industry Dummy, 3500	0.295	3.394	0.294	3.405	0.295	3.390	0.212	4.707
Industry Dummy, 3700	0.357	2.799	0.357	2.801	0.357	2.798	0.269	3.719
Industry Dummy, 4500	0.290	3.446	0.240	4.169	0.274	3.650	0.258	3.870
Industry Dummy, 5500	0.410	2.437	0.411	2.433	0.411	2.436	0.309	3.240
Industry Dummy, 9500	0.141	7.102	0.142	7.030	0.148	6.772	0.105	9.549

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.11 VIF RD/TA 2009, 2014

Dependent:	ROA 2014		Sales Growth 2014		EBITDA margin 2014		Tobin's q 2014	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.673	1.487	0.636	1.572	0.675	1.481	0.646	1.548
Cash Ratio 2014	0.333	3.007	0.321	3.115	0.376	2.657	0.374	2.673
FA Ratio 2014	0.400	2.503	0.420	2.383	0.394	2.537	0.341	2.933
Firm Size 2014	0.468	2.136	0.458	2.185	0.470	2.127	0.454	2.201
Debt Ratio 2014	0.565	1.769	0.609	1.641	0.584	1.712	0.584	1.713
RD/TA 2008	0.300	3.331	0.308	3.248	0.376	2.656	0.326	3.072
Country Dummy, FIN	0.748	1.336	0.720	1.389	0.772	1.296	0.768	1.302
Industry Dummy, 0500	0.305	3.282	0.330	3.034	0.302	3.307	0.234	4.272
Industry Dummy, 1300	0.599	1.669	0.599	1.668	0.599	1.669	0.494	2.023
Industry Dummy, 1700	0.310	3.222	0.310	3.224	0.309	3.233	0.216	4.628
Industry Dummy, 2300	0.316	3.162	0.317	3.150	0.316	3.160	0.241	4.155
Industry Dummy, 2700	0.140	7.133	0.146	6.868	0.140	7.118	0.097	10.291
Industry Dummy, 3300	0.579	1.727	0.581	1.723	0.576	1.737	0.466	2.145
Industry Dummy, 3500	0.295	3.387	0.294	3.406	0.295	3.385	0.212	4.709
Industry Dummy, 3700	0.356	2.807	0.357	2.804	0.356	2.805	0.269	3.718
Industry Dummy, 4500	0.283	3.539	0.236	4.232	0.270	3.708	0.257	3.898
Industry Dummy, 5500	0.410	2.441	0.411	2.436	0.410	2.441	0.310	3.229
Industry Dummy, 9500	0.141	7.105	0.141	7.112	0.148	6.773	0.105	9.540

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.12 VIF RD/TA 2008, 2014

Dependent:	ROA 2015		Sales Growth 2015		EBITDA margin 2015		Tobin's q 2015	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.644	1.552	0.639	1.564	0.661	1.513	0.616	1.624
Cash Ratio 2015	0.275	3.642	0.280	3.573	0.301	3.324	0.262	3.819
FA Ratio 2015	0.365	2.742	0.367	2.723	0.364	2.750	0.361	2.767
Firm Size 2015	0.474	2.111	0.471	2.125	0.492	2.033	0.508	1.970
Debt Ratio 2015	0.497	2.014	0.511	1.958	0.529	1.890	0.554	1.805
RD/TA 2009	0.328	3.053	0.346	2.894	0.393	2.543	0.374	2.675
Country Dummy, FIN	0.767	1.303	0.771	1.298	0.777	1.286	0.766	1.306
Industry Dummy, 0500	0.284	3.526	0.284	3.517	0.278	3.595	0.199	5.016
Industry Dummy, 1300	0.597	1.676	0.597	1.676	0.597	1.675	0.491	2.039
Industry Dummy, 1700	0.310	3.226	0.310	3.221	0.310	3.228	0.215	4.648
Industry Dummy, 2300	0.313	3.191	0.313	3.194	0.313	3.195	0.241	4.150
Industry Dummy, 2700	0.142	7.063	0.145	6.873	0.142	7.060	0.098	10.158
Industry Dummy, 3300	0.589	1.698	0.589	1.698	0.584	1.713	0.470	2.128
Industry Dummy, 3500	0.294	3.396	0.293	3.412	0.295	3.393	0.207	4.820
Industry Dummy, 3700	0.355	2.816	0.355	2.819	0.355	2.817	0.269	3.713
Industry Dummy, 4500	0.244	4.100	0.239	4.182	0.272	3.671	0.284	3.517
Industry Dummy, 5500	0.403	2.484	0.402	2.485	0.402	2.488	0.306	3.266
Industry Dummy, 9500	0.152	6.576	0.145	6.873	0.152	6.559	0.112	8.968

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.13 VIF RD/TA 2009, 2015

Dependent:	ROA 2015		Sales Growth 2015		EBITDA margin 2015		Tobin's q 2015	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.636	1.573	0.633	1.580	0.652	1.533	0.604	1.655
Cash Ratio 2015	0.328	3.051	0.324	3.082	0.377	2.650	0.339	2.954
FA Ratio 2015	0.382	2.618	0.385	2.594	0.379	2.640	0.379	2.641
Firm Size 2015	0.474	2.111	0.476	2.102	0.487	2.052	0.506	1.976
Debt Ratio 2015	0.452	2.212	0.482	2.075	0.498	2.008	0.504	1.984
RD/TA 2008	0.337	2.966	0.339	2.946	0.408	2.453	0.430	2.326
Country Dummy, FIN	0.753	1.328	0.775	1.290	0.776	1.288	0.774	1.292
Industry Dummy, 0500	0.305	3.276	0.306	3.263	0.301	3.323	0.216	4.620
Industry Dummy, 1300	0.596	1.679	0.596	1.678	0.596	1.677	0.489	2.045
Industry Dummy, 1700	0.310	3.230	0.310	3.225	0.310	3.230	0.214	4.666
Industry Dummy, 2300	0.314	3.189	0.314	3.189	0.313	3.195	0.241	4.151
Industry Dummy, 2700	0.143	7.016	0.146	6.832	0.143	7.005	0.099	10.121
Industry Dummy, 3300	0.586	1.706	0.587	1.705	0.582	1.717	0.468	2.136
Industry Dummy, 3500	0.294	3.398	0.292	3.423	0.295	3.391	0.208	4.808
Industry Dummy, 3700	0.355	2.816	0.355	2.817	0.355	2.819	0.269	3.723
Industry Dummy, 4500	0.237	4.225	0.235	4.255	0.268	3.738	0.286	3.495
Industry Dummy, 5500	0.403	2.484	0.403	2.484	0.401	2.491	0.305	3.275
Industry Dummy, 9500	0.152	6.594	0.144	6.925	0.153	6.555	0.111	8.983

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.14 VIF RD/TA 2008, 2015

Dependent:	*ROA 2016*		*Sales Growth 2016*		*EBITDA margin 2016*		*Tobin's q 2016*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.644	1.552	0.640	1.563	0.651	1.537	0.661	1.514
Cash Ratio 2016	0.366	2.732	0.325	3.074	0.374	2.674	0.365	2.737
FA Ratio 2016	0.335	2.985	0.326	3.065	0.331	3.017	0.336	2.972
Firm Size 2016	0.489	2.045	0.464	2.154	0.489	2.044	0.520	1.924
Debt Ratio 2016	0.644	1.553	0.698	1.432	0.680	1.471	0.681	1.468
RD/TA 2009	0.418	2.392	0.429	2.330	0.470	2.130	0.528	1.895
Country Dummy, FIN	0.769	1.300	0.771	1.297	0.789	1.267	0.757	1.322
Industry Dummy, 0500	0.286	3.496	0.284	3.522	0.284	3.519	0.283	3.535
Industry Dummy, 1300	0.591	1.691	0.592	1.690	0.592	1.691	0.591	1.693
Industry Dummy, 1700	0.307	3.255	0.307	3.258	0.307	3.256	0.309	3.236
Industry Dummy, 2300	0.316	3.160	0.316	3.166	0.316	3.166	0.314	3.183
Industry Dummy, 2700	0.144	6.951	0.144	6.944	0.144	6.927	0.146	6.868
Industry Dummy, 3300	0.590	1.696	0.586	1.705	0.586	1.706	0.579	1.726
Industry Dummy, 3500	0.296	3.380	0.296	3.380	0.296	3.377	0.303	3.305
Industry Dummy, 3700	0.358	2.795	0.358	2.794	0.358	2.793	0.354	2.823
Industry Dummy, 4500	0.294	3.402	0.238	4.201	0.280	3.577	0.462	2.163
Industry Dummy, 5500	0.405	2.472	0.403	2.483	0.403	2.481	0.394	2.538
Industry Dummy, 9500	0.141	7.075	0.148	6.750	0.148	6.761	0.153	6.517

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.15 VIF RD/TA 2009, 2016

Dependent:	*ROA 2016*		*Sales Growth 2016*		*EBITDA margin 2016*		*Tobin's q 2016*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.641	1.559	0.636	1.572	0.647	1.545	0.659	1.516
Cash Ratio 2016	0.391	2.557	0.379	2.639	0.430	2.326	0.404	2.478
FA Ratio 2016	0.341	2.931	0.329	3.039	0.334	2.994	0.344	2.907
Firm Size 2016	0.493	2.029	0.465	2.148	0.490	2.042	0.514	1.945
Debt Ratio 2016	0.607	1.648	0.654	1.528	0.643	1.556	0.648	1.544
RD/TA 2008	0.363	2.756	0.441	2.270	0.453	2.207	0.476	2.100
Country Dummy, FIN	0.758	1.320	0.765	1.308	0.781	1.280	0.763	1.310
Industry Dummy, 0500	0.313	3.197	0.310	3.224	0.310	3.221	0.309	3.236
Industry Dummy, 1300	0.592	1.689	0.592	1.688	0.592	1.689	0.592	1.690
Industry Dummy, 1700	0.307	3.252	0.307	3.257	0.307	3.254	0.309	3.234
Industry Dummy, 2300	0.317	3.158	0.316	3.165	0.316	3.166	0.314	3.185
Industry Dummy, 2700	0.145	6.920	0.145	6.911	0.145	6.893	0.146	6.838
Industry Dummy, 3300	0.587	1.704	0.585	1.710	0.584	1.711	0.577	1.732
Industry Dummy, 3500	0.296	3.380	0.296	3.380	0.296	3.377	0.308	3.250
Industry Dummy, 3700	0.357	2.800	0.357	2.799	0.357	2.798	0.353	2.833
Industry Dummy, 4500	0.291	3.435	0.236	4.238	0.277	3.605	0.484	2.068
Industry Dummy, 5500	0.404	2.475	0.402	2.489	0.402	2.488	0.393	2.546
Industry Dummy, 9500	0.141	7.081	0.148	6.753	0.148	6.761	0.154	6.502

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.16 VIF RD/TA 2008, 2016

Dependent:	*ROA 2017*		*Sales Growth 2017*		*EBITDA margin 2017*		*Tobin's q 2017*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.650	1.539	0.656	1.526	0.667	1.499	0.671	1.490
Cash Ratio 2017	0.463	2.160	0.463	2.160	0.555	1.801	0.692	1.445
FA Ratio 2017	0.295	3.391	0.311	3.211	0.313	3.199	0.321	3.114
Firm Size 2017	0.459	2.177	0.458	2.182	0.480	2.081	0.520	1.923
Debt Ratio 2017	0.653	1.532	0.649	1.542	0.660	1.514	0.661	1.514
RD/TA 2009	0.463	2.158	0.462	2.163	0.556	1.798	0.607	1.648
Country Dummy, FIN	0.764	1.308	0.762	1.312	0.789	1.268	0.797	1.255
Industry Dummy, 0500	0.279	3.590	0.281	3.563	0.278	3.601	0.277	3.615
Industry Dummy, 1300	0.598	1.672	0.598	1.672	0.597	1.674	0.597	1.675
Industry Dummy, 1700	0.314	3.185	0.314	3.181	0.315	3.178	0.335	2.986
Industry Dummy, 2300	0.306	3.263	0.307	3.258	0.306	3.265	0.307	3.257
Industry Dummy, 2700	0.140	7.123	0.137	7.278	0.138	7.237	0.140	7.156
Industry Dummy, 3300	0.593	1.686	0.593	1.686	0.591	1.693	0.589	1.699
Industry Dummy, 3500	0.297	3.364	0.297	3.366	0.297	3.370	0.293	3.408
Industry Dummy, 3700	0.352	2.845	0.351	2.846	0.352	2.844	0.351	2.848
Industry Dummy, 4500	0.248	4.035	0.248	4.036	0.280	3.574	0.404	2.472
Industry Dummy, 5500	0.392	2.548	0.393	2.545	0.392	2.551	0.388	2.577
Industry Dummy, 9500	0.136	7.358	0.136	7.357	0.142	7.048	0.149	6.712

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.17 VIF RD/TA 2009, 2017

Dependent:	*ROA 2017*		*Sales Growth 2017*		*EBITDA margin 2017*		*Tobin's q 2017*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.646	1.548	0.652	1.533	0.662	1.510	0.668	1.497
Cash Ratio 2017	0.517	1.935	0.517	1.936	0.618	1.618	0.741	1.349
FA Ratio 2017	0.295	3.386	0.312	3.207	0.306	3.269	0.326	3.072
Firm Size 2017	0.465	2.150	0.464	2.154	0.482	2.074	0.520	1.922
Debt Ratio 2017	0.640	1.563	0.636	1.574	0.658	1.520	0.653	1.532
RD/TA 2008	0.486	2.059	0.484	2.066	0.564	1.772	0.590	1.694
Country Dummy, FIN	0.760	1.316	0.758	1.319	0.795	1.259	0.792	1.262
Industry Dummy, 0500	0.304	3.294	0.306	3.266	0.302	3.314	0.301	3.326
Industry Dummy, 1300	0.598	1.672	0.598	1.672	0.598	1.673	0.598	1.673
Industry Dummy, 1700	0.314	3.184	0.315	3.180	0.315	3.179	0.334	2.990
Industry Dummy, 2300	0.307	3.262	0.307	3.257	0.306	3.270	0.307	3.261
Industry Dummy, 2700	0.141	7.082	0.138	7.235	0.139	7.191	0.141	7.110
Industry Dummy, 3300	0.593	1.688	0.592	1.688	0.591	1.693	0.588	1.701
Industry Dummy, 3500	0.297	3.366	0.297	3.368	0.296	3.379	0.295	3.395
Industry Dummy, 3700	0.351	2.847	0.351	2.848	0.351	2.848	0.351	2.852
Industry Dummy, 4500	0.249	4.019	0.249	4.021	0.281	3.563	0.401	2.491
Industry Dummy, 5500	0.392	2.552	0.392	2.549	0.390	2.561	0.388	2.578
Industry Dummy, 9500	0.136	7.358	0.136	7.359	0.142	7.037	0.149	6.693

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.18 VIF RD/TA 2008, 2017

Dependent:	ROA 2018		Sales Growth 2018		EBITDA margin 2018		Tobin's q 2018	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.647	1.545	0.643	1.555	0.645	1.551	0.649	1.541
Cash Ratio 2018	0.443	2.257	0.423	2.362	0.500	2.001	0.458	2.183
FA Ratio 2018	0.326	3.069	0.336	2.978	0.331	3.019	0.336	2.980
Firm Size 2018	0.494	2.024	0.482	2.076	0.494	2.024	0.496	2.016
Debt Ratio 2018	0.603	1.657	0.600	1.668	0.641	1.560	0.610	1.639
RD/TA 2009	0.507	1.974	0.468	2.136	0.545	1.835	0.452	2.212
Country Dummy, FIN	0.772	1.295	0.754	1.326	0.788	1.270	0.751	1.332
Industry Dummy, 0500	0.288	3.477	0.288	3.467	0.287	3.487	0.287	3.482
Industry Dummy, 1300	0.599	1.670	0.599	1.669	0.599	1.670	0.599	1.671
Industry Dummy, 1700	0.309	3.240	0.309	3.237	0.309	3.238	0.334	2.995
Industry Dummy, 2300	0.313	3.196	0.313	3.194	0.313	3.197	0.313	3.192
Industry Dummy, 2700	0.139	7.174	0.139	7.202	0.140	7.154	0.140	7.136
Industry Dummy, 3300	0.590	1.695	0.591	1.692	0.586	1.707	0.590	1.695
Industry Dummy, 3500	0.293	3.417	0.293	3.413	0.292	3.419	0.293	3.414
Industry Dummy, 3700	0.350	2.858	0.350	2.859	0.350	2.856	0.350	2.861
Industry Dummy, 4500	0.230	4.351	0.236	4.230	0.273	3.668	0.261	3.828
Industry Dummy, 5500	0.384	2.603	0.384	2.604	0.383	2.611	0.381	2.625
Industry Dummy, 9500	0.143	6.980	0.137	7.301	0.143	6.974	0.143	6.975

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.19 VIF RD/TA 2009, 2018

Dependent:	ROA 2018		Sales Growth 2018		EBITDA margin 2018		Tobin's q 2018	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.645	1.551	0.642	1.557	0.644	1.553	0.648	1.542
Cash Ratio 2018	0.495	2.018	0.472	2.118	0.554	1.804	0.523	1.912
FA Ratio 2018	0.330	3.034	0.347	2.884	0.335	2.982	0.340	2.941
Firm Size 2018	0.494	2.024	0.482	2.075	0.495	2.019	0.496	2.014
Debt Ratio 2018	0.608	1.645	0.599	1.669	0.646	1.547	0.615	1.627
RD/TA 2008	0.543	1.841	0.501	1.997	0.553	1.808	0.510	1.959
Country Dummy, FIN	0.777	1.287	0.754	1.326	0.794	1.259	0.756	1.322
Industry Dummy, 0500	0.319	3.134	0.320	3.121	0.318	3.144	0.319	3.137
Industry Dummy, 1300	0.599	1.670	0.599	1.669	0.599	1.670	0.598	1.671
Industry Dummy, 1700	0.309	3.237	0.309	3.235	0.309	3.235	0.334	2.993
Industry Dummy, 2300	0.312	3.201	0.313	3.196	0.312	3.202	0.313	3.199
Industry Dummy, 2700	0.140	7.144	0.139	7.173	0.140	7.122	0.141	7.101
Industry Dummy, 3300	0.591	1.693	0.591	1.692	0.586	1.705	0.590	1.694
Industry Dummy, 3500	0.292	3.420	0.293	3.410	0.292	3.422	0.293	3.416
Industry Dummy, 3700	0.349	2.864	0.349	2.866	0.349	2.862	0.349	2.868
Industry Dummy, 4500	0.230	4.354	0.236	4.243	0.272	3.671	0.263	3.801
Industry Dummy, 5500	0.382	2.615	0.383	2.614	0.381	2.624	0.379	2.636
Industry Dummy, 9500	0.143	6.992	0.137	7.326	0.143	6.985	0.143	6.987

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA is research and development spending to total assets (as percentage).

Appendix 7.20 VIF RD/TA 2008, 2018

Increased R&D activities during recessionary years

Dependent:	ROA 2011		Sales Growth 2011		EBITDA margin 2011		Tobin's q 2011	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.641	1.559	0.649	1.541	0.633	1.579	0.614	1.630
Cash Ratio 2011	0.387	2.582	0.423	2.362	0.451	2.216	0.393	2.548
FA Ratio 20111	0.436	2.295	0.425	2.356	0.423	2.364	0.422	2.369
Firm Size 2011	0.456	2.194	0.452	2.212	0.479	2.088	0.438	2.283
Debt Ratio 2011	0.501	1.997	0.538	1.858	0.573	1.746	0.484	2.068
RD/TA Dummy	0.777	1.287	0.767	1.304	0.789	1.267	0.764	1.308
Country Dummy, FIN	0.723	1.384	0.751	1.331	0.789	1.267	0.722	1.386
Industry Dummy, 0500	0.300	3.331	0.330	3.032	0.322	3.104	0.238	4.210
Industry Dummy, 1300	0.607	1.647	0.607	1.647	0.607	1.646	0.506	1.976
Industry Dummy, 1700	0.315	3.172	0.316	3.163	0.316	3.168	0.221	4.520
Industry Dummy, 2300	0.297	3.370	0.294	3.406	0.295	3.389	0.237	4.212
Industry Dummy, 2700	0.136	7.326	0.140	7.123	0.142	7.044	0.097	10.323
Industry Dummy, 3300	0.581	1.722	0.578	1.731	0.579	1.727	0.474	2.108
Industry Dummy, 3500	0.343	2.919	0.343	2.915	0.343	2.913	0.251	3.988
Industry Dummy, 3700	0.351	2.850	0.349	2.869	0.351	2.853	0.271	3.694
Industry Dummy, 4500	0.256	3.908	0.267	3.740	0.281	3.557	0.190	5.273
Industry Dummy, 5500	0.401	2.496	0.396	2.522	0.398	2.510	0.307	3.262
Industry Dummy, 9500	0.144	6.955	0.140	7.166	0.149	6.698	0.108	9.217

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.21 VIF RD/TA Dummy, 2011

Dependent:	ROA 2012		Sales Growth 2012		EBITDA margin 2012		Tobin's q 2012	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.643	1.555	0.666	1.502	0.650	1.539	0.619	1.615
Cash Ratio 2012	0.513	1.949	0.474	2.108	0.492	2.033	0.508	1.968
FA Ratio 2012	0.412	2.428	0.407	2.459	0.391	2.560	0.377	2.653
Firm Size 2012	0.468	2.136	0.443	2.256	0.518	1.932	0.454	2.202
Debt Ratio 2012	0.555	1.801	0.584	1.711	0.671	1.489	0.597	1.675
RD/TA Dummy	0.827	1.209	0.832	1.202	0.753	1.327	0.846	1.182
Country Dummy, FIN	0.717	1.395	0.689	1.451	0.778	1.285	0.741	1.349
Industry Dummy, 0500	0.292	3.422	0.292	3.420	0.308	3.248	0.225	4.442
Industry Dummy, 1300	0.605	1.652	0.605	1.652	0.604	1.656	0.503	1.987
Industry Dummy, 1700	0.314	3.189	0.313	3.195	0.311	3.213	0.219	4.574
Industry Dummy, 2300	0.305	3.280	0.308	3.250	0.300	3.331	0.241	4.149
Industry Dummy, 2700	0.144	6.930	0.139	7.196	0.142	7.040	0.101	9.937
Industry Dummy, 3300	0.593	1.685	0.594	1.683	0.573	1.745	0.478	2.093
Industry Dummy, 3500	0.307	3.261	0.308	3.244	0.346	2.889	0.221	4.516
Industry Dummy, 3700	0.355	2.821	0.356	2.808	0.345	2.898	0.272	3.678
Industry Dummy, 4500	0.270	3.703	0.279	3.584	0.371	2.695	0.228	4.380
Industry Dummy, 5500	0.404	2.478	0.403	2.480	0.401	2.495	0.308	3.245
Industry Dummy, 9500	0.155	6.435	0.142	7.062	0.145	6.900	0.107	9.380

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.22 VIF RD/TA Dummy, 2012

Dependent:	*ROA 2013*		*Sales Growth 2013*		*EBITDA margin 2013*		*Tobin's q 2013*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.675	1.481	0.697	1.436	0.663	1.508	0.675	1.482
Cash Ratio 2013	0.526	1.902	0.539	1.856	0.608	1.644	0.621	1.611
FA Ratio 2013	0.435	2.300	0.430	2.323	0.445	2.249	0.407	2.459
Firm Size 2013	0.448	2.233	0.443	2.257	0.487	2.053	0.479	2.087
Debt Ratio 2013	0.672	1.488	0.712	1.404	0.713	1.403	0.636	1.572
RD/TA Dummy	0.847	1.180	0.838	1.193	0.826	1.210	0.828	1.207
Country Dummy, FIN	0.752	1.329	0.744	1.344	0.802	1.246	0.767	1.303
Industry Dummy, 0500	0.292	3.421	0.292	3.424	0.336	2.972	0.225	4.454
Industry Dummy, 1300	0.602	1.660	0.603	1.658	0.603	1.658	0.496	2.015
Industry Dummy, 1700	0.316	3.162	0.316	3.164	0.317	3.156	0.221	4.522
Industry Dummy, 2300	0.310	3.224	0.313	3.195	0.309	3.234	0.240	4.161
Industry Dummy, 2700	0.144	6.924	0.139	7.174	0.145	6.876	0.102	9.851
Industry Dummy, 3300	0.592	1.689	0.593	1.688	0.588	1.700	0.476	2.099
Industry Dummy, 3500	0.302	3.316	0.302	3.312	0.302	3.316	0.216	4.620
Industry Dummy, 3700	0.353	2.829	0.355	2.814	0.353	2.832	0.270	3.698
Industry Dummy, 4500	0.291	3.436	0.280	3.570	0.351	2.846	0.258	3.878
Industry Dummy, 5500	0.406	2.463	0.407	2.456	0.406	2.462	0.310	3.230
Industry Dummy, 9500	0.138	7.238	0.140	7.126	0.144	6.942	0.124	8.087

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.23 VIF RD/TA Dummy, 2013

Dependent:	*ROA 2014*		*Sales Growth 2014*		*EBITDA margin 2014*		*Tobin's q 2014*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.676	1.480	0.636	1.571	0.679	1.472	0.658	1.520
Cash Ratio 2014	0.510	1.960	0.473	2.113	0.502	1.993	0.518	1.930
FA Ratio 2014	0.395	2.533	0.419	2.387	0.391	2.560	0.346	2.892
Firm Size 2014	0.482	2.076	0.465	2.149	0.485	2.060	0.467	2.140
Debt Ratio 2014	0.635	1.574	0.682	1.467	0.653	1.531	0.680	1.470
RD/TA Dummy	0.844	1.185	0.850	1.176	0.847	1.180	0.813	1.229
Country Dummy, FIN	0.746	1.341	0.732	1.367	0.768	1.302	0.753	1.328
Industry Dummy, 0500	0.283	3.535	0.333	3.006	0.281	3.560	0.217	4.619
Industry Dummy, 1300	0.599	1.668	0.599	1.668	0.599	1.669	0.496	2.016
Industry Dummy, 1700	0.310	3.217	0.311	3.217	0.310	3.229	0.217	4.606
Industry Dummy, 2300	0.316	3.207	0.312	3.207	0.312	3.204	0.240	4.165
Industry Dummy, 2700	0.140	7.111	0.147	6.824	0.141	7.103	0.097	10.320
Industry Dummy, 3300	0.579	1.706	0.586	1.706	0.582	1.719	0.473	2.113
Industry Dummy, 3500	0.295	3.383	0.294	3.398	0.296	3.380	0.213	4.698
Industry Dummy, 3700	0.356	2.818	0.354	2.825	0.355	2.816	0.270	3.701
Industry Dummy, 4500	0.283	3.444	0.240	4.164	0.275	3.632	0.261	3.827
Industry Dummy, 5500	0.410	2.438	0.410	2.436	0.410	2.437	0.307	3.257
Industry Dummy, 9500	0.141	7.169	0.141	7.088	0.146	6.838	0.105	9.550

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.24 VIF RD/TA Dummy, 2014

Dependent:	*ROA 2015*		*Sales Growth 2015*		*EBITDA margin 2015*		*Tobin's q 2015*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.643	1.555	0.637	1.569	0.660	1.515	0.614	1.629
Cash Ratio 2015	0.447	2.237	0.447	2.236	0.475	2.106	0.367	2.722
FA Ratio 2015	0.360	2.775	0.364	2.745	0.359	2.782	0.357	2.798
Firm Size 2015	0.482	2.076	0.479	2.087	0.503	1.987	0.516	1.938
Debt Ratio 2015	0.493	2.029	0.509	1.965	0.528	1.895	0.554	1.804
RD/TA Dummy	0.812	1.231	0.822	1.216	0.826	1.211	0.798	1.253
Country Dummy, FIN	0.790	1.265	0.796	1.256	0.825	1.212	0.794	1.259
Industry Dummy, 0500	0.285	3.503	0.286	3.500	0.281	3.559	0.200	4.995
Industry Dummy, 1300	0.596	1.677	0.596	1.678	0.597	1.676	0.491	2.038
Industry Dummy, 1700	0.310	3.227	0.310	3.223	0.310	3.228	0.215	4.652
Industry Dummy, 2300	0.306	3.271	0.306	3.268	0.306	3.271	0.238	4.199
Industry Dummy, 2700	0.142	7.043	0.146	6.851	0.142	7.029	0.098	10.155
Industry Dummy, 3300	0.589	1.699	0.588	1.700	0.585	1.709	0.472	2.117
Industry Dummy, 3500	0.295	3.388	0.294	3.399	0.296	3.381	0.210	4.771
Industry Dummy, 3700	0.351	2.845	0.351	2.848	0.351	2.846	0.269	3.723
Industry Dummy, 4500	0.244	4.097	0.239	4.188	0.273	3.661	0.285	3.506
Industry Dummy, 5500	0.402	2.487	0.402	2.488	0.401	2.492	0.305	3.278
Industry Dummy, 9500	0.150	6.648	0.144	6.931	0.151	6.619	0.111	8.975

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.25 VIF RD/TA Dummy, 2015

Dependent:	*ROA 2016*		*Sales Growth 2016*		*EBITDA margin 2016*		*Tobin's q 2016*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.638	1.568	0.633	1.580	0.644	1.553	0.656	1.525
Cash Ratio 2016	0.507	1.971	0.429	2.330	0.490	2.041	0.433	2.312
FA Ratio 2016	0.340	2.943	0.329	3.035	0.335	2.988	0.346	2.894
Firm Size 2016	0.497	2.014	0.470	2.129	0.495	2.019	0.516	1.937
Debt Ratio 2016	0.639	1.565	0.692	1.444	0.674	1.484	0.680	1.470
RD/TA Dummy	0.825	1.212	0.823	1.215	0.828	1.208	0.796	1.257
Country Dummy, FIN	0.796	1.256	0.799	1.251	0.818	1.222	0.786	1.272
Industry Dummy, 0500	0.285	3.506	0.283	3.530	0.284	3.526	0.283	3.539
Industry Dummy, 1300	0.592	1.691	0.592	1.689	0.592	1.690	0.591	1.692
Industry Dummy, 1700	0.307	3.257	0.307	3.261	0.307	3.259	0.309	3.239
Industry Dummy, 2300	0.311	3.213	0.310	3.222	0.310	3.222	0.306	3.272
Industry Dummy, 2700	0.144	6.932	0.144	6.927	0.145	6.908	0.146	6.837
Industry Dummy, 3300	0.588	1.699	0.586	1.707	0.586	1.708	0.579	1.726
Industry Dummy, 3500	0.298	3.353	0.298	3.354	0.298	3.350	0.309	3.237
Industry Dummy, 3700	0.355	2.817	0.355	2.816	0.355	2.815	0.349	2.862
Industry Dummy, 4500	0.294	3.400	0.238	4.201	0.280	3.577	0.486	2.059
Industry Dummy, 5500	0.402	2.488	0.400	2.498	0.401	2.496	0.394	2.539
Industry Dummy, 9500	0.141	7.117	0.147	6.791	0.147	6.804	0.152	6.569

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.26 VIF RD/TA Dummy, 2016

Dependent:	*ROA 2018*		*Sales Growth 2018*		*EBITDA margin 2018*		*Tobin's q 2018*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.644	1.553	0.640	1.563	0.642	1.558	0.646	1.547
Cash Ratio 2018	0.507	1.971	0.506	1.975	0.577	1.734	0.540	1.851
FA Ratio 2018	0.332	3.014	0.339	2.946	0.337	2.970	0.342	2.927
Firm Size 2018	0.502	1.993	0.490	2.040	0.500	2.001	0.506	1.975
Debt Ratio 2018	0.594	1.685	0.591	1.693	0.631	1.586	0.602	1.660
RD/TA Dummy	0.833	1.200	0.830	1.205	0.838	1.194	0.837	1.194
Country Dummy, FIN	0.807	1.239	0.794	1.260	0.827	1.209	0.776	1.289
Industry Dummy, 0500	0.287	3.487	0.288	3.477	0.286	3.497	0.286	3.491
Industry Dummy, 1300	0.599	1.670	0.599	1.670	0.599	1.670	0.599	1.670
Industry Dummy, 1700	0.309	3.241	0.309	3.239	0.309	3.239	0.334	2.998
Industry Dummy, 2300	0.307	3.253	0.308	3.251	0.307	3.255	0.308	3.250
Industry Dummy, 2700	0.140	7.159	0.139	7.187	0.140	7.136	0.141	7.115
Industry Dummy, 3300	0.588	1.700	0.590	1.696	0.585	1.710	0.588	1.699
Industry Dummy, 3500	0.294	3.401	0.294	3.401	0.294	3.401	0.294	3.397
Industry Dummy, 3700	0.348	2.877	0.347	2.879	0.348	2.875	0.347	2.879
Industry Dummy, 4500	0.231	4.334	0.237	4.227	0.274	3.653	0.266	3.766
Industry Dummy, 5500	0.386	2.592	0.386	2.593	0.385	2.596	0.384	2.605
Industry Dummy, 9500	0.142	7.024	0.136	7.338	0.142	7.020	0.142	7.024

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.28 VIF RD/TA Dummy, 2018

Dependent:	*ROA 2017*		*Sales Growth 2017*		*EBITDA margin 2017*		*Tobin's q 2017*	
Variables	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Firm Age	0.640	1.561	0.651	1.536	0.663	1.509	0.668	1.498
Cash Ratio 2017	0.554	1.806	0.554	1.804	0.624	1.602	0.746	1.341
FA Ratio 2017	0.302	3.316	0.317	3.151	0.320	3.129	0.342	2.920
Firm Size 2017	0.465	2.149	0.466	2.147	0.489	2.046	0.525	1.905
Debt Ratio 2017	0.642	1.558	0.638	1.567	0.650	1.540	0.656	1.525
RD/TA Dummy	0.809	1.236	0.831	1.204	0.838	1.194	0.833	1.200
Country Dummy, FIN	0.815	1.226	0.812	1.231	0.840	1.191	0.806	1.241
Industry Dummy, 0500	0.277	3.606	0.280	3.570	0.277	3.607	0.276	3.624
Industry Dummy, 1300	0.598	1.673	0.598	1.673	0.597	1.674	0.597	1.674
Industry Dummy, 1700	0.314	3.189	0.314	3.183	0.314	3.180	0.334	2.991
Industry Dummy, 2300	0.301	3.317	0.301	3.319	0.300	3.328	0.301	3.319
Industry Dummy, 2700	0.141	7.108	0.138	7.257	0.139	7.213	0.140	7.129
Industry Dummy, 3300	0.591	1.693	0.591	1.692	0.589	1.698	0.585	1.708
Industry Dummy, 3500	0.298	3.361	0.297	3.362	0.297	3.364	0.295	3.384
Industry Dummy, 3700	0.349	2.867	0.349	2.869	0.349	2.867	0.348	2.870
Industry Dummy, 4500	0.249	4.014	0.249	4.016	0.282	3.542	0.404	2.477
Industry Dummy, 5500	0.390	2.562	0.391	2.555	0.391	2.559	0.389	2.571
Industry Dummy, 9500	0.135	7.395	0.135	7.406	0.141	7.103	0.148	6.747

Note: Firm Age is the natural logarithm of the firm age in 2018, Cash Ratio is the cash holdings in relation to total assets (as percentage), FA Ratio is fixed assets to total assets (as percentage), Firm Size is natural logarithm of total assets, Debt Ratio is total debt to total assets (as percentage), ROA is return on assets (as percentage), EBITDA margin is earnings before interest, depreciation and amortization to total sales (as percentage), Sales Growth is current year sales minus last year sales and divided by last year sales (as percentage), Tobin's q is market capitalisation plus total debt divided by total assets, RD/TA Dummy assumes value of 1 if firm increased RD/TA intensity both 2008 and 2009.

Appendix 7.27 VIF RD/TA Dummy, 2018

Appendix 8.

R&D activities and recessionary performance

Full Model	ROA		EBITDA Margin		Sales Growth		Tobin's q	
	2008	2009	2008	2009	2008	2009	2008	2009
Focus Variable								
R&D/S 2007	-.393**	0.486	-.646**	-.281	-.507	-.498	0.454	-.112
Control Variables	(0.151)	(0.492)	(0.258)	(0.324)	(0.510)	(0.309)	(1.078)	(1.215)
Debt Ratio	-.047	-.290*	-.035	-.322***	0.017	0.145	0.086	-.802
	(0.094)	(0.180)	(0.149)	(0.103)	(0.314)	(0.250)	(0.558)	(0.773)
Cash Ratio	0.042	-.073	0.082	-.194	0.062	0.270	0.440	1.271
	(0.094)	(0.147)	(0.133)	(0.126)	(0.468)	(0.382)	(1.130)	(0.945)
FA/TA	0.037	0.206*	0.215	0.218	-.166	0.095	0.115	0.348
	(0.082)	(0.119)	(0.131)	(0.185)	(0.244)	(0.269)	(0.499)	(0.589)
Size	0.014	0.028*	0.023**	0.030*	0.010	0.019	0.022	0.023
	(0.010)	(0.015)	(0.012)	(0.017)	(0.020)	(0.018)	(0.040)	(0.053)
Firm Age	0.009	0.011	-.002	-.001	-.039	0.026	0.110	0.093
	(0.011)	(0.017)	(0.018)	(0.021)	(0.035)	(0.042)	(0.082)	(0.126)
Constant	-.075	-.175	0.053	0.168	0.195	-.355	0.369	1.073
	(0.116)	(0.160)	(0.149)	(0.207)	(0.277)	(0.336)	(0.811)	(1.014)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83	82	81	81	83	83	80	80
R-Square	0.430	0.545	0.515	0.507	0.384	0.304	0.323	0.280
F-value	2.687	4.199	3.663	3.538	2.213	1.550	1.617	1.320

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.1 Pre-recessionary R&D activities RD/S 2007, full model regression results

Recessionary R&D activities and later firm performance

Control models

Control Model: ROA	ROA		ROA		ROA		ROA		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Control Variables									
Debt Ratio	-.200	-.210*	-.259*	-.132	-.236**	-.238	-.212	-.362**	-.173*
	(0.118)	(0.107)	(0.135)	(0.151)	(0.109)	(0.154)	(0.246)	(0.142)	(0.102)
Cash Ratio	-.152	-.199	-.142	-.413	-.257	-.253	-.396	-.696***	0.105
	(0.154)	(0.227)	(0.213)	(0.349)	(0.289)	(0.231)	(0.397)	(0.254)	(0.177)
FA/TA	0.102	-.075	-.049	0.037	0.094	0.132	0.339**	-.053	0.262**
	(0.084)	(0.116)	(0.131)	(0.137)	(0.114)	(0.140)	(0.159)	(0.160)	(0.120)
Size	0.025***	0.023**	0.024*	0.029**	0.024***	0.028***	0.023*	0.007	0.019*
	(0.008)	(0.011)	(0.014)	(0.151)	(0.008)	(0.009)	(0.013)	(0.008)	(0.011)
Firm Age	0.002	0.019	0.022	0.009	0.029*	0.008	-.020	0.011	0.001
	(0.017)	(0.008)	(0.020)	(0.017)	(0.017)	(0.020)	(0.025)	(0.019)	(0.019)
Constant	-.096	-.065	-.105	-.153	-.154	-.140	0.018	0.217	-.079
	(0.120)	(0.148)	(0.201)	(0.169)	(0.130)	(0.146)	(0.231)	(0.140)	(0.141)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	87	86	87	88	87	87	88	88
R-Square	0.431	0.284	0.364	0.364	0.504	0.419	0.180	0.521	0.343
F-value	3.072	1.613	2.285	2.321	4.189	2.930	0.892	4.480	2.153

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.2 ROA 2010-2018, control model regression results

Control Model: EBITDA Margin	EBITDA Margin		EBITDA Margin		EBITDA Margin		EBITDA Margin		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Control Variables									
Debt Ratio	-.187*	-.330***	-.390***	-.184	0.081	0.077	-.082	-.162	-.162
	(0.105)	(0.099)	(0.131)	(0.265)	(0.196)	(0.237)	(0.218)	(0.149)	(0.149)
Cash Ratio	-.075	-.524*	-.494	-.280	-.034	-.138	-.180	-.283	0.127
	(0.134)	(0.295)	(0.396)	(0.648)	(0.799)	(0.400)	(0.458)	(0.435)	(0.194)
FA/TA	0.065	0.029	0.070	0.270	0.405*	0.264	0.332*	0.040	0.292**
	(0.110)	(0.148)	(0.096)	(0.211)	(0.225)	(0.207)	(0.176)	(0.163)	(0.126)
Size	0.019**	0.017	0.013	0.048**	0.051**	0.038***	0.031**	0.009	0.030**
	(0.008)	(0.012)	(0.009)	(0.018)	(0.020)	(0.014)	(0.013)	(0.010)	(0.012)
Firm Age	-.001	0.001	-.023	-.008	-.011	0.035	-.011	0.001	-.030
	(0.017)	(0.026)	(0.023)	(0.035)	(0.034)	(0.034)	(0.023)	(0.020)	(0.022)
Constant	0.233*	0.327	0.480***	-.073	-.259	-.292	0.074	0.287*	0.234
	(0.125)	(0.208)	(0.166)	(0.297)	(0.346)	(0.348)	(0.231)	(0.170)	(0.148)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83	83	81	83	87	86	86	87	87
R-Square	0.487	0.539	0.481	0.463	0.445	0.403	0.344	0.266	0.324
F-value	3.634	4.468	3.438	3.303	3.254	2.703	2.100	1.475	1.944

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.3 EBITDA margin 2010-2018, control model regression results

Control Model: Sales Growth	Sales Growth		Sales Growth		Sales Growth		Sales Growth		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Control Variables									
Debt Ratio	-.218	0.035	-.032	-.254	-.520***	0.710	-.176	-.209	-.142
	(0.297)	(0.124)	(0.252)	(0.334)	(0.148)	(0.520)	(0.132)	(0.300)	(0.172)
Cash Ratio	0.223	0.051	0.535	-.241	'-.409	-.309	-.014	-.282	-.283
	(0.661)	(0.191)	(0.683)	(0.364)	(0.439)	(0.344)	(0.302)	(0.487)	(0.298)
FA/TA	-.126	0.189	0.255	-.414	0.137	-.939***	0.144	-.323	-.173
	(0.277)	(0.187)	(0.361)	(0.541)	(0.232)	(0.335)	(0.237)	(0.323)	(0.291)
Size	0.003	0.010	0.021	-.011	0.000	-.043*	0.022	-.016	0.002
	(0.024)	(0.013)	(0.026)	(0.025)	(0.013)	(0.022)	(0.024)	(0.022)	(0.014)
Firm Age	-.023	-.031	-.101	0.048	-.030	0.081	-.009	0.037	0.002
	(0.045)	(0.027)	(0.069)	(0.057)	(0.025)	(0.056)	(0.035)	(0.045)	(0.028)
Constant	0.179	-.006	0.195	0.025	0.559***	0.028	-.075	0.289	0.121
	(0.282)	(0.199)	(0.316)	(0.389)	(0.195)	(0.461)	(0.409)	(0.330)	(0.239)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	84	89	89	86	87	87	89	89
R-Square	0.180	0.331	0.210	0.131	0.447	0.328	0.241	0.095	0.108
F-value	0.891	1.924	1.109	0.629	3.234	1.984	1.287	0.436	0.504

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.4 Sales growth 2010-2018, control model regression results

Control Model: Tobin's q	Tobin's q		Tobin's q		Tobin's q		Tobin's q		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Control Variables									
Debt Ratio	-.755	-.406	0.473	-.835	-.774	-.800	0.854	-.516	-.420
	(0.862)	(0.549)	(1.091)	(0.781)	(0.680)	(0.965)	(0.792)	(0.547)	(0.465)
Cash Ratio	0.963	1.049	1.477*	-.745	2.083	0.918	1.830	1.157	0.412
	(0.864)	(0.722)	(0.754)	(2.561)	(1.516)	(3.319)	(1.639)	(1.394)	(1.337)
FA/TA	-.221	0.482	0.057	-.743	0.181	-.031**	-1.485	-.123	-.291
	(0.584)	(0.477)	(0.699)	(0.883)	(0.689)	(0.980)	(1.463)	(0.714)	(0.683)
Size	0.035	0.019	0.043	0.033	0.063	0.005	-.050	0.050	0.036
	(0.061)	(0.044)	(0.061)	(0.055)	(0.051)	(0.068)	(0.073)	(0.066)	(0.059)
Firm Age	0.064	0.093	0.179	0.069	0.036	0.146	0.099	0.040	0.040
	(0.133)	(0.107)	(0.131)	(0.120)	(0.097)	(0.122)	(0.112)	(0.113)	(0.125)
Constant	1.329	0.978	0.129	2.019*	1.551	2.122	1.695*	1.871**	2.283***
	(1.066)	(0.852)	(1.308)	(1.126)	(1.017)	(1.455)	(0.965)	(0.910)	(0.766)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85	84	84	80	84	83	80	83	86
R-Square	0.283	0.342	0.320	0.439	0.547	0.36	0.298	0.346	0.409
F-value	1.558	2.020	1.829	2.852	4.684	2.153	1.551	2.020	2.767

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.5 Tobin's q 2010-2018, control model regression results

Full models

ROA

Full Model: ROA	ROA		ROA		ROA		ROA		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2008	-.162	-.658	-.618	-.169	-.111	-.206	-.687**	-.297	-.146
Control Variables	(0.446)	(0.551)	(0.594)	(0.596)	(0.224)	(0.292)	(0.334)	(0.346)	(0.284)
Debt Ratio	-.196	-.205*	-.242*	-.162	-.253**	-.296*	-.300	-.400	-.184*
	(0.121)	(0.105)	(0.143)	(0.154)	(0.111)	(0.167)	(0.253)	(0.134)	(0.106)
Cash Ratio	-.086	-.012	0.091	-.347	-.200	-.180	-.110	-.625**	0.139
	(0.122)	(0.223)	(0.294)	(0.338)	(0.306)	(0.292)	(0.362)	(0.281)	(0.206)
FA/TA	0.130	-.063	-.076	0.055	0.088	0.124	0.263	-.090	0.220
	(0.107)	(0.132)	(0.130)	(0.161)	(0.117)	(0.141)	(0.171)	(0.188)	(0.137)
Size	0.025***	0.019*	0.020	0.029**	0.023**	0.026**	0.017	0.004	0.016
	(0.009)	(0.011)	(0.013)	(0.013)	(0.009)	(0.011)	(0.012)	(0.009)	(0.012)
Firm Age	0.004	0.020	0.027	0.005	0.029*	0.007	-.019	0.010	0.001
	(0.016)	(0.016)	(0.018)	(0.020)	(0.017)	(0.019)	(0.024)	(0.021)	(0.021)
Constant	-.117	-.091	-.093	-.126	-.131	-.077	0.153	0.292*	-.037
	(0.121)	(0.145)	(0.184)	(0.199)	(0.139)	(0.166)	(0.255)	(0.174)	(0.165)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86	86	85	86	87	86	86	87	87
R-Square	0.437	0.351	0.415	0.375	0.506	0.436	0.252	0.552	0.376
F-value	2.888	2.011	2.598	2.230	3.877	2.882	1.255	4.654	2.278

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.6 ROA 2010-2018, full model regression results, RD/TA 2008

Full Model: ROA	ROA		ROA		ROA		ROA		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2009	-.211	-.527***	-.582	-.242	-.058	-.193	-.606*	-.247	-.179
Control Variables	(0.345)	(0.196)	(0.373)	(0.238)	(0.161)	(0.363)	(0.342)	(0.231)	(0.198)
Debt Ratio	-.174	-.166*	-.219	-.141	-.238**	-.242	-.204	-.359**	-.171
	(0.116)	(0.091)	(0.139)	(0.159)	(0.108)	(0.158)	(0.246)	(0.140)	(0.103)
Cash Ratio	-.070	-.048	0.084	-.271	-.215	-.140	-.041	-.597**	0.174
	(0.163)	(0.214)	(0.233)	(0.371)	(0.348)	(0.317)	(0.416)	(0.284)	(0.220)
FA/TA	0.108	-.050	-.028	0.032	0.091	0.123	0.270	-.093	0.233*
	(0.085)	(0.102)	(0.110)	(0.144)	(0.114)	(0.145)	(0.175)	(0.179)	(0.134)
Size	0.024***	0.018*	0.017	0.027**	0.023***	0.026***	0.017	0.005	0.017
	(0.008)	(0.010)	(0.017)	(0.012)	(0.008)	(0.010)	(0.012)	(0.008)	(0.011)
Firm Age	0.005	0.015	0.026	0.007	0.029*	0.009	-.017	0.010	0.001
	(0.016)	(0.016)	(0.017)	(0.018)	(0.017)	(0.018)	(0.021)	(0.019)	(0.020)
Constant	-.110	-.074	-.084	-.125	-.147	-.120	0.070	0.257	-.049
	(0.113)	(0.125)	(0.164)	(0.180)	(0.129)	(0.150)	(0.230)	(0.162)	(0.159)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	87	86	87	88	87	87	88	88
R-Square	0.455	0.395	0.495	0.381	0.506	0.433	0.267	0.543	0.359
F-value	3.148	2.463	3.646	2.324	3.923	2.883	1.378	4.561	2.150

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.7 ROA 2010-2018, full model regression results, RD/TA 2009

EBITDA margin

Full Model: EBITDA Margin	EBITDA Margin		EBITDA Margin		EBITDA Margin		EBITDA Margin		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2008	-.037	-.515	-.204	-.979**	-1.071**	-.706	-.547	-.550	-.340
Control Variables	(0.330)	(0.812)	(0.536)	(0.477)	(0.419)	(0.756)	(0.365)	(0.349)	(0.328)
Debt Ratio	-.187*	-.321***	-.384***	-.185	-.084	-.133	-.187	-.144	-.187
	(0.106)	(0.100)	(0.129)	(0.245)	(0.184)	(0.188)	(0.199)	(0.153)	(0.146)
Cash Ratio	-.066	-.442	0.068	0.021	0.469	0.132	0.054	-.179	0.242
	(0.138)	(0.346)	(0.339)	(0.586)	(0.828)	(0.504)	(0.469)	(0.390)	(0.221)
FA/TA	0.064	0.026	.068	0.179	0.341	0.230	0.279*	-.032	0.196
	(0.110)	(0.146)	(0.096)	(0.204)	(0.211)	(0.156)	(0.160)	(0.177)	(0.131)
Size	0.018***	0.014	0.013	0.038**	0.040**	0.032***	0.026**	0.002	0.025**
	(0.008)	(0.011)	(0.009)	(0.015)	(0.018)	(0.011)	(0.012)	(0.011)	(0.011)
Firm Age	-.001	0.007	-.020	-.010	-.014	0.027	-.015	-.002	-.033
	(0.018)	(0.025)	(0.023)	(0.028)	(0.028)	(0.034)	(0.020)	(0.019)	(0.021)
Constant	0.232*	0.317	0.467***	0.062	-.029	-.056	0.221	0.432**	0.330**
	(0.125)	(0.207)	(0.167)	(0.246)	(0.324)	(0.258)	(0.229)	(0.199)	(0.161)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83	83	81	83	86	85	85	86	86
R-Square	0.488	0.559	0.486	0.559	0.529	0.492	0.412	0.335	0.361
F-value	3.382	4.505	3.251	4.509	4.185	3.557	2.569	1.877	2.101

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.8 EBITDA margin 2010-2018, full model regression results, RD/TA 2008

Full Model: EBITDA Margin	EBITDA Margin		EBITDA Margin		EBITDA Margin		EBITDA Margin		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2009	0.082	-.626*	-.142	-.838	-.918***	-.543	-.502*	-.389	-.194
Control Variables	(0.226)	(0.374)	(0.538)	(0.531)	(0.228)	(0.503)	(0.281)	(0.408)	(0.234)
Debt Ratio	-.188*	-.278**	-.380***	-.204	0.047	0.092	-.078	-.064	-.160
	(0.105)	(0.113)	(0.130)	(0.314)	(0.179)	(0.245)	(0.217)	(0.151)	(0.152)
Cash Ratio	-.087	-.381	-.460	0.329	0.689	0.251	0.143	-.124	0.220
	(0.139)	(0.296)	(0.412)	(0.446)	(0.756)	(0.517)	(0.450)	(0.432)	(0.244)
FA/TA	0.067	0.048	0.067	0.240	0.373*	0.243	0.281	-.028	0.261*
	(0.110)	(0.128)	(0.097)	(0.208)	(0.199)	(0.197)	(0.189)	(0.196)	(0.139)
Size	0.019**	0.010	0.013	0.042**	0.044**	0.032**	0.027**	0.005	0.028**
	(0.008)	(0.009)	(0.009)	(0.016)	(0.017)	(0.012)	(0.012)	(0.010)	(0.012)
Firm Age	-.002	0.009	-.021	-.014	-.016	0.038	-.008	0.000	-.031
	(0.017)	(0.023)	(0.022)	(0.029)	(0.029)	(0.033)	(0.021)	(0.019)	(0.022)
Constant	0.234*	0.324*	0.469***	0.025	-.155	-.250	0.114	0.347*	0.265*
	(0.126)	(0.182)	(0.162)	(0.252)	(0.281)	(0.314)	(0.226)	(0.186)	(0.156)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83	83	81	83	87	86	86	87	87
R-Square	0.489	0.641	0.483	0.577	0.553	0.461	0.414	0.325	0.340
F-value	3.402	6.353	3.223	4.857	4.678	3.189	2.630	1.822	1.946

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.9 EBITDA margin 2010-2018, full model regression results, RD/TA 2009

Sales growth

Full Model: Sales Growth	Sales Growth		Sales Growth		Sales Growth		Sales Growth		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2008	-.320	-.230	0.529	-.067	0.046	-.281	0.510	0.436	0.234
Control Variables	(1.403)	(0.387)	(1.274)	(0.481)	(0.759)	(0.384)	(0.587)	(0.978)	(0.625)
Debt Ratio	-.199	0.029	-.040	-.470**	-.513***	0.241	-.137	-.228	-.136
	(0.312)	(0.117)	(0.272)	(0.236)	(0.144)	(0.262)	(0.122)	(0.284)	(0.170)
Cash Ratio	0.355	0.117	0.275	-.251	-.428	-.286	-.158	-.354	-.325
	(0.531)	(0.212)	(0.395)	(0.348)	(0.511)	(0.334)	(0.361)	(0.614)	(0.293)
FA/TA	-.060	0.273	0.223	-.009	0.139	-.942**	0.218	-.183	-.156
	(0.311)	(0.188)	(0.395)	(0.247)	(0.249)	(0.452)	(0.180)	(0.369)	(0.343)
Size	0.002	0.013	0.025	-.003	0.000	-.040	0.027	-.014	0.004
	(0.025)	(0.013)	(0.026)	(0.022)	(0.014)	(0.024)	(0.024)	(0.023)	(0.013)
Firm Age	-.021	-.033	-.105	-.009	-.030	0.046	-.014	0.028	-.001
	(0.049)	(0.027)	(0.074)	(0.041)	(0.027)	(0.039)	(0.037)	(0.046)	(0.029)
Constant	0.135	-.052	0.198	0.332	0.550**	0.428	-.153	0.240	0.095
	(0.306)	(0.207)	(0.344)	(0.345)	(0.212)	(0.279)	(0.376)	(0.341)	(0.215)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	86	83	88	88	86	86	86	88	88
R-Square	0.180	0.360	0.216	0.331	0.447	0.379	0.317	0.103	0.124
F-value	0.819	2.000	1.056	1.901	3.012	2.274	1.724	0.439	0.543

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.10 Sales growth 2010-2018, full model regression results, RD/TA 2008

Full Model: Sales Growth	Sales Growth		Sales Growth		Sales Growth		Sales Growth		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2009	-1.005	-.117	0.307	-.140	0.213	0.698*	0.333	0.351	0.137
Control Variables	(0.963)	(0.447)	(0.857)	(0.340)	(0.317)	(0.388)	(0.342)	(0.675)	(0.372)
Debt Ratio	-.087	0.048	-.059	-.259	-.508***	0.698	-.178	-.214	-.141
	(0.234)	(0.122)	(0.268)	(0.332)	(0.155)	(0.509)	(0.134)	(0.302)	(0.173)
Cash Ratio	0.657	0.087	0.406	-.166	-.551	-.715*	-.225	-.423	-.344
	(0.870)	(0.225)	(0.749)	(0.362)	(0.518)	(0.369)	(0.350)	(0.552)	(0.300)
FA/TA	-.086	0.191	0.241	-.416	0.147	-.901**	0.177	-.267	-.155
	(0.273)	(0.188)	(0.360)	(0.548)	(0.227)	(0.360)	(0.208)	(0.338)	(0.301)
Size	-.005	0.009	0.025	-.012	0.001	-.035	0.025	-.013	0.004
	(0.021)	(0.013)	(0.027)	(0.026)	(0.013)	(0.023)	(0.024)	(0.021)	(0.014)
Firm Age	-.011	-.029	-.103	0.047	-.029	0.077	-.010	0.038	0.003
	(0.040)	(0.027)	(0.070)	(0.057)	(0.026)	(0.055)	(0.035)	(0.046)	(0.028)
Constant	0.109	-.010	0.186	0.268	0.531***	-.031	-.102	0.232	0.097
	(0.300)	(0.200)	(0.340)	(0.408)	(0.192)	(0.478)	(0.391)	(0.319)	(0.223)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	84	89	89	86	87	87	89	89
R-Square	0.263	0.336	0.218	0.133	0.458	0.359	0.274	0.108	0.113
F-value	1.351	1.829	1.084	0.594	3.142	2.116	1.426	0.469	0.497

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.11 Sales growth 2010-2018, full model regression results, RD/TA 2009

Tobin's q

Full Model: Tobin's q	Tobin's q		Tobin's q		Tobin's q		Tobin's q		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2008	3.038	2.185	2.287	3.135	1.177	2.265	1.202	1.995	2.301
Control Variables	(2.796)	(1.851)	(1.588)	(2.316)	(1.050)	(2.486)	(1.280)	(1.472)	(1.821)
Debt Ratio	-.816	-.441	0.432	-.664	-.636	-.527	1.020	-.432	-.347
	(0.875)	(0.581)	(1.093)	(0.824)	(0.742)	(0.875)	(0.852)	(0.609)	(0.397)
Cash Ratio	-.130	0.421	0.525	-1.641	1.565	0.276	1.407	0.921	0.044
	(1.590)	(1.085)	(1.001)	(2.393)	(1.671)	(3.621)	(1.745)	(1.450)	(1.186)
FA/TA	-.331	0.469	0.142	-.222	0.348	0.143	-1.319	0.365	0.177
	(0.752)	(0.575)	(0.781)	(0.874)	(0.691)	(1.116)	(1.615)	(0.782)	(0.745)
Size	0.049	0.033	0.050	0.061	0.077	0.031	-.037	0.069	0.060
	(0.068)	(0.049)	(0.067)	(0.057)	(0.057)	(0.081)	(0.082)	(0.070)	(0.056)
Firm Age	0.012	0.049	0.168	0.064	0.031	0.137	0.103	0.032	0.031
	(0.136)	(0.112)	(0.130)	(0.119)	(0.102)	(0.136)	(0.116)	(0.119)	(0.133)
Constant	1.575	1.107	0.162	1.558*	1.315	1.675	1.393	1.457	1.854**
	(1.114)	(0.876)	(1.318)	(0.870)	(1.090)	(1.514)	(1.085)	(1.083)	(0.919)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	84	83	83	79	83	82	79	82	85
R-Square	0.323	0.384	0.346	0.501	0.554	0.392	0.311	0.388	0.459
F-value	1.723	2.218	1.878	3.350	4.416	2.261	1.508	2.223	3.110

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.12 Tobin's q 2010-2018, full model regression results, RD/TA 2008

Full Model: Tobin's q	Tobin's q		Tobin's q		Tobin's q		Tobin's q		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 2009	2.998***	1.720	3.586*	2.199	4.180	2.428	2.486	3.355	0.698
Control Variables	(1.135)	(1.146)	(1.805)	(3.029)	(2.572)	(2.727)	(1.920)	(2.795)	(2.073)
Debt Ratio	-1.216	-.566	0.185	-.626	-.460	-.768	0.890	-.507	-.427
	(0.751)	(0.488)	(0.936)	(0.787)	(0.645)	(0.978)	(0.837)	(0.570)	(0.453)
Cash Ratio	-.227	0.548	-.290	-1.551	0.086	-.295	0.685	0.316	0.129
	(1.028)	(0.819)	(1.066)	(2.837)	(1.883)	(3.288)	(1.605)	(1.450)	(1.543)
FA/TA	-.244	0.429	0.241	-.561	0.599	0.120	-1.178	0.530	-.178
	(0.571)	(0.490)	(0.695)	(0.862)	(0.751)	(1.115)	(1.650)	(0.811)	(0.793)
Size	0.066	0.038	0.056	0.040	0.099*	0.025	-.034	0.069	0.042
	(0.066)	(0.048)	(0.066)	(0.056)	(0.057)	(0.073)	(0.082)	(0.072)	(0.058)
Firm Age	0.027	0.067	0.159	0.092	0.069	0.144	0.114	0.059	0.045
	(0.140)	(0.113)	(0.126)	(0.116)	(0.118)	(0.136)	(0.116)	(0.126)	(0.130)
Constant	1.561	1.043	0.303	1.691*	0.788	1.882	1.370	1.365	2.162**
	(1.145)	(0.914)	(1.305)	(1.008)	(1.239)	(1.572)	(1.140)	(1.183)	(0.860)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85	84	84	80	84	83	80	83	86
R-Square	0.408	0.419	0.401	0.466	0.636	0.391	0.346	0.439	0.416
F-value	2.524	2.609	2.415	2.952	6.316	2.284	1.795	2.782	2.647

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.13 Tobin's q 2010-2018, full model regression results, RD/TA 2009

Increased R&D activities during recessionary years

ROA

Full Model: ROA	ROA		ROA		ROA		ROA		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 08&09Dummy	0.019	0.059	0.011	0.005	-.030	-.059*	-.051	0.029	-.019
Control Variables	(0.023)	(0.040)	(0.042)	(0.037)	(0.031)	(0.032)	(0.057)	(0.038)	(0.031)
Debt Ratio	-.205*	-.232**	-.259*	-.133	-.240**	-.256*	-.224	-.352**	-.179*
	(0.118)	(0.116)	(0.136)	(0.153)	(0.106)	(0.149)	(0.247)	(0.140)	(0.101)
Cash Ratio	-.156	-.222	-.145	-.413	-.264	-.262	-.411	-.686***	0.098
	(0.153)	(0.221)	(0.221)	(0.354)	(0.286)	(0.220)	(0.397)	(0.255)	(0.174)
FA/TA	0.089	-.122	-.055	0.035	0.106	0.160	0.346**	-.054	0.268**
	(0.083)	(0.122)	(0.147)	(0.143)	(0.118)	(0.134)	(0.164)	(0.158)	(0.125)
Size	0.025***	0.024*	0.024*	0.029**	0.024***	0.030***	0.024*	0.007	0.019*
	(0.008)	(0.011)	(0.014)	(0.012)	(0.009)	(0.009)	(0.013)	(0.008)	(0.011)
Firm Age	0.000	0.001	0.021	0.009	0.031*	0.011	-.016	0.009	-.019
	(0.018)	(0.020)	(0.022)	(0.018)	(0.017)	(0.019)	(0.025)	(0.019)	(0.020)
Constant	-.081	-.009	-.100	-.151	-.160	-.153	0.012	0.219	-.079
	(0.120)	(0.146)	(0.212)	(0.180)	(0.129)	(0.141)	(0.231)	(0.138)	(0.145)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	87	86	87	88	87	87	88	88
R-Square	0.435	0.291	0.364	0.364	0.514	0.451	0.193	0.526	0.347
F-value	2.906	1.700	2.134	2.162	4.059	3.100	0.904	4.257	2.033

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.14 ROA 2010-2018, full model regression results, increased R&D dummy

EBITDA margin

Full Model: EBITDA Margin	EBITDA Margin		EBITDA Margin		EBITDA Margin		EBITDA Margin		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 08&09Dummy	-.001	-.037	-.017	0.003	-.080	-.110	-.057	0.028	-.003
Control Variables	(0.024)	(0.049)	(0.037)	(0.052)	(0.070)	(0.066)	(0.051)	(0.053)	(0.039)
Debt Ratio	-.186*	-.317***	-.384***	-.185	0.070	0.053	-.097	-.067	-.164
	(0.108)	(0.097)	(0.128)	(0.268)	(0.187)	(0.224)	(0.221)	(0.148)	(0.146)
Cash Ratio	-.075	-.509	-.499	-.282	-.043	-.147	-.187	-.274	0.126
	(0.135)	(0.286)	(0.399)	(0.649)	(0.784)	(0.344)	(0.436)	(0.431)	(0.206)
FA/TA	0.065	0.056	0.083	0.269	0.438*	0.316	0.342*	0.031	0.293**
	(0.115)	(0.165)	(0.101)	(0.223)	(0.231)	(0.211)	(0.181)	(0.170)	(0.126)
Size	0.019**	0.018	0.014	0.048**	0.052**	0.042***	0.033**	0.009	0.030**
	(0.008)	(0.012)	(0.009)	(0.019)	(0.020)	(0.014)	(0.013)	(0.011)	(0.012)
Firm Age	-.001	0.005	-.021	-.008	-.006	0.039	-.007	-.001	-.029
	(0.018)	(0.028)	(0.023)	(0.037)	(0.033)	(0.033)	(0.023)	(0.020)	(0.023)
Constant	0.232*	0.292	0.464***	-.071	-.274	-.321	0.067	0.287	0.234
	(0.131)	(0.213)	(0.170)	(0.317)	(0.340)	(0.335)	(0.231)	(0.173)	(0.151)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	83	83	81	83	87	86	86	87	87
R-Square	0.487	0.418	0.484	0.464	0.467	0.463	0.363	0.272	0.324
F-value	3.379	4.272	3.234	3.072	3.309	3.215	2.119	1.410	1.810

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.15 EBITDA margin 2010-2018, full model regression results, increased R&D dummy

Sales growth

Full Model: Sales Growth	Sales Growth		Sales Growth		Sales Growth		Sales Growth		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 08&09Dummy	-.010	0.004	0.000	0.103	0.032	0.100	0.092	0.132	0.001
Control Variables	(0.058)	(0.046)	(0.070)	(0.084)	(0.042)	(0.086)	(0.055)	(0.107)	(0.071)
Debt Ratio	-.215	0.037	-.032	-.260	-.516***	0.715	-.171	-.156	-.142
	(0.300)	(0.130)	(0.255)	(0.334)	(0.156)	(0.517)	(0.133)	(0.292)	(0.170)
Cash Ratio	0.225	0.051	0.255	-.236	-.396	-.284	0.000	-.223	-.283
	(0.664)	(0.196)	(0.688)	(0.345)	(0.436)	(0.339)	(0.272)	(0.480)	(0.294)
FA/TA	-.119	0.186	0.255	-.445	0.129	-.979***	0.128	-.362	-.173
	(0.284)	(0.197)	(0.378)	(0.529)	(0.233)	(0.343)	(0.223)	(0.334)	(0.301)
Size	0.003	0.010	0.021	-.014	-.001	-.046**	0.020	-.020	0.002
	(0.024)	(0.013)	(0.026)	(0.025)	(0.013)	(0.022)	(0.023)	(0.023)	(0.016)
Firm Age	-.022	-.031	-.101	0.041	-.029	0.086	-.007	0.043	0.002
	(0.048)	(0.028)	(0.069)	(0.059)	(0.025)	(0.056)	(0.033)	(0.045)	(0.028)
Constant	0.171	-.008	0.195	0.288	0.540***	-.007	-.114	0.200	0.121
	(0.296)	(0.205)	(0.323)	(0.396)	(0.190)	(0.466)	(0.379)	(0.307)	(0.228)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	87	84	89	89	86	87	87	89	89
R-Square	0.180	0.331	0.210	0.151	0.453	0.344	0.296	0.128	0.108
F-value	0.830	1.790	1.033	0.693	3.084	1.984	1.589	0.570	0.469

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.16 Sales growth 2010-2018, full model regression results, increased R&D dummy

Tobin's q

Full Model: Tobin's q	Tobin's q		Tobin's q		Tobin's q		Tobin's q		
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Focus Variable									
R&D/TA 08&09Dummy	0.229	0.054	0.195	0.156	0.216	0.097	0.174	-.059	-.170
Control Variables	(0.193)	(0.174)	(0.184)	(0.200)	(0.200)	(0.193)	(0.200)	(0.219)	(0.197)
Debt Ratio	-.712	-.399	0.466	-.809	-.719	-.817	0.838	-.536	-.491
	(0.896)	(0.564)	(1.087)	(0.795)	(0.680)	(0.960)	(0.765)	(0.575)	(0.470)
Cash Ratio	1.025	1.052	1.459*	-.673	2.215	0.875	1.789	1.124	0.314
	(0.882)	(0.739)	(0.735)	(2.639)	(1.475)	(3.302)	(1.610)	(1.523)	(1.387)
FA/TA	-.304	0.448	-.004	-.752	0.163	-.076	-1.547	-.105	-.224
	(0.649)	(0.534)	(0.756)	(0.893)	(0.708)	(0.995)	(1.492)	(0.746)	(0.693)
Size	0.033	0.018	0.043	0.029	0.059	0.001	-.058	0.052	0.041
	(0.063)	(0.044)	(0.063)	(0.055)	(0.052)	(0.069)	(0.072)	(0.065)	(0.059)
Firm Age	0.059	0.093	0.179	0.072	0.043	0.148	0.105	0.038	0.030
	(0.136)	(0.109)	(0.133)	(0.118)	(0.098)	(0.123)	(0.109)	(0.115)	(0.128)
Constant	1.273	0.976	0.074	1.955*	1.429	2.135	1.674*	1.905**	2.404***
	(1.073)	(0.866)	(1.352)	(1.077)	(0.983)	(1.430)	(0.975)	(0.948)	(0.813)
Industry Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	85	84	84	80	84	83	80	83	86
R-Square	0.300	0.344	0.337	0.446	0.557	0.363	0.308	0.347	0.417
F-value	1.571	1.891	1.833	2.725	4.533	2.023	1.509	1.887	2.660

*Note: *** p < 0.01, ** p < 0.05, * p <0.10. Robust standard errors in brackets.*

Appendix 8.17 Tobin's q 2010-2018, full model regression results, increased R&D dummy